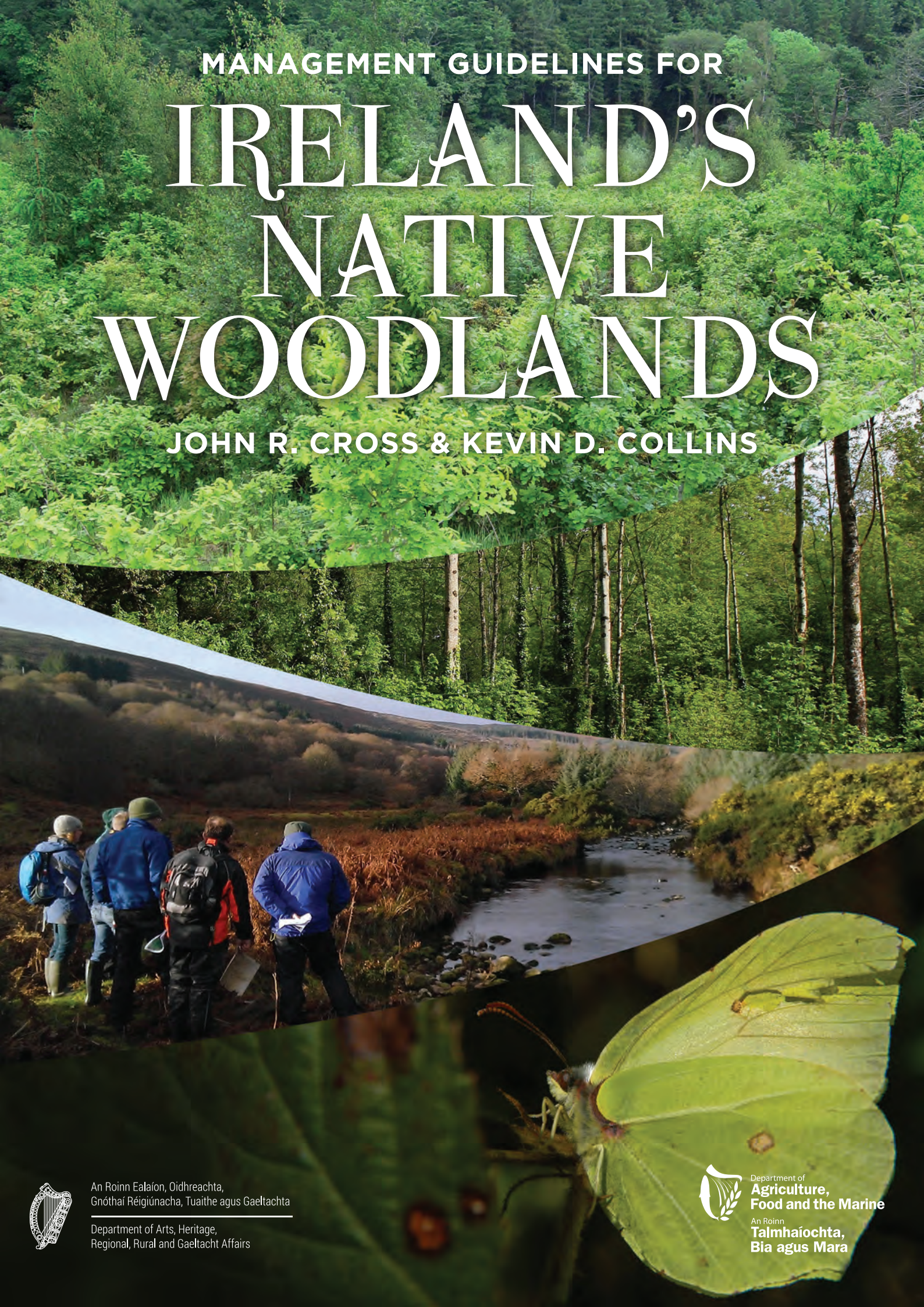
MANAGEMENT GUIDELINES FOR

IRELAND'S NATIVE WOODLANDS

JOHN R. CROSS & KEVIN D. COLLINS



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Foreword

Since the foundation of the State, Government policy has been to expand the area of forest cover in Ireland. Over the last 100 years, forest cover has increased from about one percent of the land area of the State to just under 11% today. The new forests mainly comprise fast-growing, non-native conifers which now form an important resource of renewable raw material and which contribute significantly to the economy. Alongside these forests are areas of native woodland, whose multi-faceted value is becoming increasingly recognised.

Although these native woodlands cover less than two percent of the land area, they are perhaps the most complex and biodiverse habitats in the country. They range from ancient oak and ash woodlands, some of which are over 400 years old, to naturally emerging woodlands such as birch wood colonising cutaway bog, to recently planted woods. As well as representing reservoirs of biodiversity, these deliver other important ecosystem services, such as water and soil protection, wider habitat linkage and carbon sequestration. Native woodlands have a significant economic potential too, as a source of quality hardwood, renewable energy and other wood and non-wood products, and as the basis for enterprises offering outdoor activities and holidaying experiences. They are also part of the scenic landscape and the rich heritage that visitors come to Ireland to experience and to enjoy. In addition, native woodlands represent an invaluable resource for local communities and school children to enjoy and to interpret their local heritage and the wider natural world.

While some of these woodlands are carefully managed, both by private landowners and the State, many are under threat from various sources, such as invasive non-native species and overgrazing. Others have been unmanaged for many years. Skilful intervention, using close-to-nature management systems, is required to ensure their survival and to conserve and enhance their biodiversity value, which is a requirement in certain cases under the EU Habitats Directive. Careful management will also promote their potential for wood production, as is recognised under the Forestry Programme. Similarly, the expansion of Ireland's native woodland resource, through afforestation on

new sites and the conversion of existing non-native forests, will further these objectives and will enable native woodlands to be focused where water protection, habitat linkage and other ecosystem services are most needed.

Between them, the authors combine many years of experience of ecology and forestry and have produced an attractive and practical set of guidelines offering clear and concise guidance for the management of our native woodlands. As the Ministers responsible for nature conservation policy and forest policy in Ireland, we welcome the cooperation between our two Departments and strongly recommend this manual to all involved in the management of our native woodlands, including foresters, ecologists and landowners. We believe that these *Management Guidelines for Ireland's Native Woodlands* will contribute significantly to enhancing the quality and encouraging the expansion of this vital component of Ireland's natural, historical and cultural heritage.

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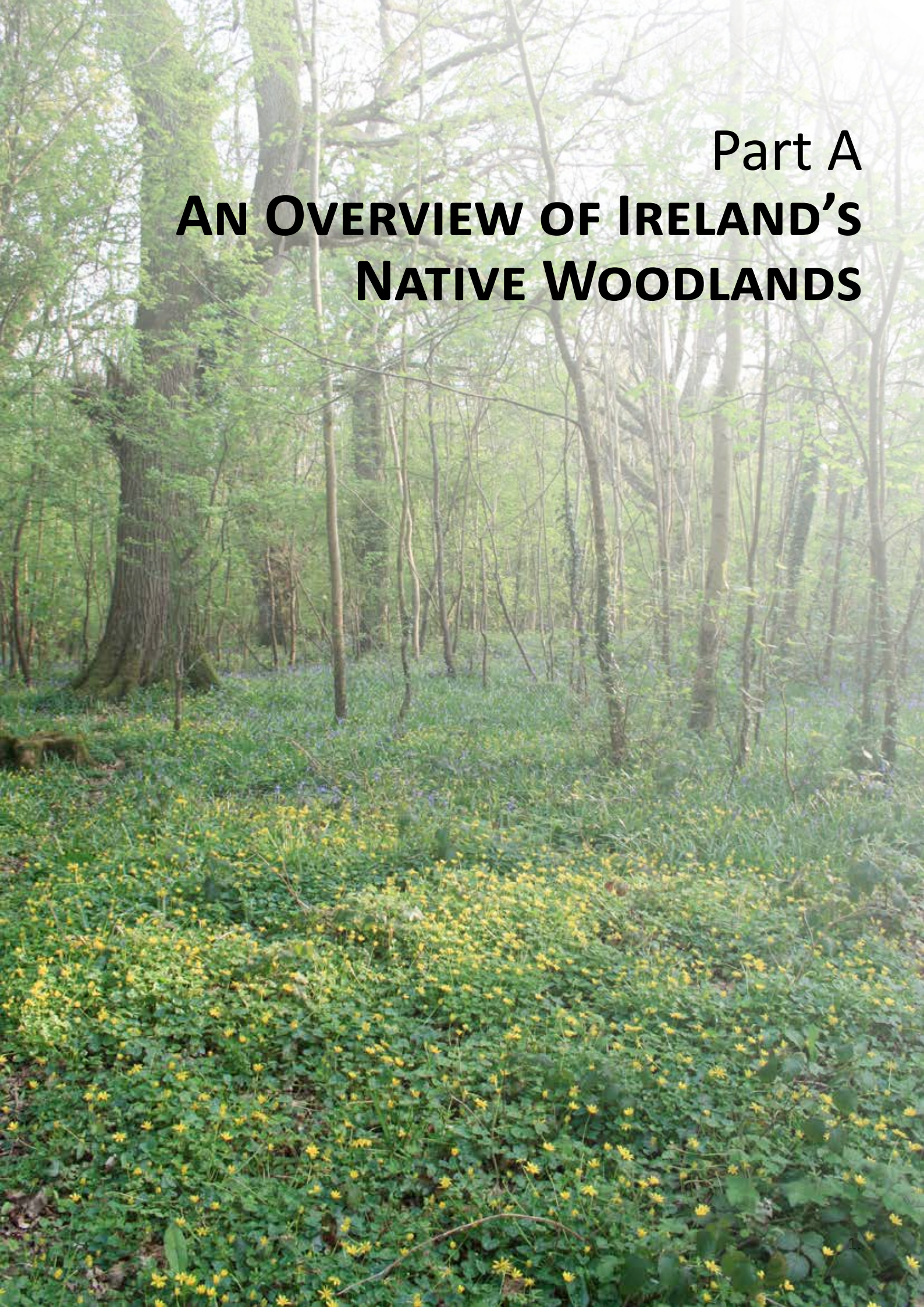

Part A
An Overview of Ireland's Native Woodlands

1. Introduction

Ireland's native woodland – a vital resource

The decline of our native woodlands is well-documented (Mitchell & Ryan, 1997; Kelly, 2005) and those that are present today in the Irish landscape are either fragments of former forests or relatively recent in origin (Rackham, 2005; Perrin & Daly, 2010). Nearly all of our native woodlands have been modified in structure and species due to past silvicultural management. For example, evidence of previous coppicing with oak standards is a common feature in many remaining oak-dominated woodlands in Ireland. In addition, they have been reduced in size, fragmented, restocked with non-native species or provenances, or felled and replaced entirely with exotic conifers. Today's native woodlands therefore bear little resemblance to the original natural woodland cover, and it would be futile to attempt to restore them to this state, even if we knew what such woodlands were like. Nonetheless, our native woodlands are still an important repository of biodiversity, represent the most complex and biodiverse of all of our native vegetation types, and are of both national and international significance (Cross, 2006; Bohn *et al.*, 2003). They are also robust ecosystems that have a remarkable ability to recover from often long periods of inappropriate management or neglect.

Since the start of the new millennium, a great deal of attention has been focused on Ireland's native woodlands. A series of major initiatives, programmes and projects have been undertaken, including the inception of Woodlands of Ireland, the Forest Service Native Woodland Scheme support package, the People's Millennium Forests Project, Coillte's Restoring Priority Woodland Habitats LIFE Project and Old Woodland Survey, and the National Survey of Native Woodlands 2003-2008 (NSNW) (Perrin *et al.*, 2008) and the associated Provisional Inventory of Ancient and Long-Established Woodland (Perrin & Daly, 2010). Various organisations such as Woodlands of Ireland, Muintir na Coillte, Crann and the Native Woodland Trust have also been active during this time,

Ireland's native woodlands are the most complex and biodiverse of all of our native vegetation types and are of both national and international significance. Camillan Wood, Co. Kerry.

contributing – often instrumentally – to many of these initiatives, and using both theoretical and practical experience to highlight the importance of managing these woodlands appropriately for both conservation and wood production.

Numerous publications have also emerged to support native woodland owners and managers in their decision-making. The series of native woodland-focused information notes authored by relevant experts and published by Woodlands of Ireland (e.g. Barron, 2007; Byrnes, 2007a; Little *et al.*, 2009) is a clear example of this growing technical resource. Other key works include Horgan *et al.* (2003), Little & Cross (2005) and Huss *et al.* (2016). In addition, a significant body of training has been carried out in support of the Native Woodland Scheme since its launch in 2001, targeted at foresters, ecologists and other key players involved in the roll-out of associated projects.

Taken together, all of these initiatives have generated and disseminated a considerable amount of new knowledge regarding our native woodlands, including their distribution, classification, floristics, structure, conservation status and associated threats and also, appropriate approaches to their management.

The importance of our native woodlands has been recognised under the EU Habitats Directive, as demonstrated by the inclusion under Annex I of five woodland habitat types of relevance to Ireland, and the designation of numerous woodlands as Special Areas of Conservation (SACs), forming part of the European-wide Natura 2000 network. Under the Habitats Directive, the entire national resource of Annex I woodlands, both designated and non-designated, must be managed and restored to achieve favourable conservation status. Extending this approach to other, non-Annex woodland habitats, e.g. ash woodlands, would bring a similar conservation-led focus to other components of our native woodland resource.

While the significance of a small number of our native woodlands has been documented for many years (e.g. Killarney Woods, Brackloon Wood in Co. Mayo), surveys and research over the last 15 years – such as the National Survey of Native Woodlands (Perrin *et al.*, 2008) – have led to a better understanding of the variety and value of woodlands throughout the country. The recognition of these sites has also served to highlight the key role played by forest owners and managers – private, Coillte and others – some of whom have managed the woodlands over the decades for wood production in a manner compatible with biodiversity conservation. At the same time, the nature conservation community has developed significant knowledge regarding the conservation status of species and habitats and of methods to maintain or restore favourable conservation status.

Many of the initiatives mentioned above have been built on close working partnerships involving ecologists, foresters, owners and researchers, thereby pooling the full range of knowledge, skills and experience needed to realise the best approach to the management of native woodlands. A greater awareness has also emerged, not only of their ecological significance at both the national and European level, but also of their cultural and historical significance. The increase in interest and knowledge has also focused attention on the role of native woodlands in delivering wider ecosystem services that can contribute towards tackling other environmental challenges, as detailed by Bullock & Hawe (2014). These include the protection and enhancement of water quality and aquatic ecosystems (for example, within the context of the Water Framework Directive and the conservation of freshwater pearl mussel), the creation of corridors and 'stepping stones' between other natural and semi-natural habitats, carbon

A Native Woodland Scheme training course at Delphi, Co. Mayo, jointly held by Woodlands of Ireland and the Forest Service on the site of a new native woodland planted to protect fisheries and freshwater pearl mussel.

sequestration and landscape enhancement. Well-sited and appropriately developed native woodlands are also an invaluable resource for people of all ages and abilities to visit and enjoy, and to learn about native woodlands and the wider natural world.

An appreciation has also emerged of the potential for the realisation of quality wood and non-wood products from our native woodlands, through close-to-nature silvicultural systems that utilise natural processes, such as natural regeneration. Realising this potential creates income for the forest owner and an economic imperative to continue appropriate management. Evidence from elsewhere shows that appropriate management for wood production can be of major conservation benefit. Rackham (2003), for example, demonstrates that many ancient woodlands of high conservation interest in England have survived for centuries due to their economic value. Meanwhile, the Coed Cymru organisation (www.coed.cymru) and the Pontbren Project (www.woodlandtrust.org.uk) – both in Wales – demonstrate the advantages that can arise from the restoration of neglected native woodlands for conservation, wood production, the protection of water, and flood mitigation.

As previously outlined, the Native Woodland Scheme represents a key initiative in relation to Ireland's native woodland. This support package is implemented by the Forest Service of the Department of Agriculture, Food & the Marine (DAFM) in partnership with Woodlands of Ireland and other key stakeholders. It provides support for landowners to appropriately restore *existing* native woodland (including the conversion of non-native forest to native woodland) and to create *new* native woodland on open 'greenfield' sites (DAFM, 2015a & 2015b). The current Forestry Programme 2014-2020 sets clear targets for both elements of the scheme (i.e. conservation and establishment), not only to promote Ireland's native woodland resource and associated biodiversity, but also to realise those other ecosystem services that native woodlands are so capable of 'delivering'.

Other key developments are emerging, which focus on the value of our native woodlands. These include the Irish Forum on Natural Capital, aimed at evaluating, protecting and restoring Ireland's natural capital and ecosystem services, and the Woodlands of

Ireland's Strategy for Native Woodlands in Ireland 2016-2020 (Woodlands of Ireland, 2016). This latter initiative, compiled with input from a wide range of stakeholders, sets out for the first time a cross-sectorial vision for Ireland's native woodlands and a workable roadmap for its realisation.

These and other measures are contributing to the gradual improvement in the conservation status of Ireland's native woodlands, by supporting their appropriate management and expansion. It is within this context that this manual, entitled *Management Guidelines for Ireland's Native Woodlands*, has been prepared. It is aimed at the owners of both existing and potential woodland sites, and at ecologists, foresters and other practitioners involved in native woodland management. It is also aimed at various statutory and non-statutory bodies with an interest in native woodlands from the perspective of wider nature conservation, water and soil protection, fisheries, climate change mitigation, rural development, landscape, amenity, and environmental education.

Management Guidelines for Ireland's Native Woodlands provides two sets of management guidelines, the first addressing a range of specific topics (e.g. 'Area', 'Grazing', 'Products') and the second covering specific native woodland types, such as Oak (*Quercus petraea*[1]) Woodland, Hazel Woodland and Alluvial Woodland. It will have an obvious application to projects involving the restoration of existing native woodland, the conversion of non-native forest to native woodland, and afforestation with new native woodland, typically (but not exclusively) undertaken with support under the Native Woodland Scheme. However, it is also relevant within the context of non-native woodlands and commercial conifer forests, where the enhancement of biodiversity is an objective.

When embarking on any course of action to restore an existing native woodland, to convert a non-native forest to native woodland, or to afforest a site with new native woodland, it is important that decisions are based on appropriate ecological and forestry expertise. On any particular site, these professions will together identify the relevant priorities and objectives and the actions needed to bring about appropriate change. This essential partnership remains at the heart of the ongoing effort to restore Ireland's native woodland resource, a vital component of our natural, historical and cultural heritage.

[1] Nomenclature Preston *et al.* (2002). See Appendix 1 for the scientific name for plant species listed in this manual.

2. Characteristics of Ireland's Native Woodlands

Area and distribution

The precise area of native woodland in Ireland is difficult to quantify, as stands often contain a mixture of species, both native and non-native. In its assessment of 'nativeness', the Second National Forest Inventory (DAFM, 2013) found that native forests (defined as forests comprising >80% native species) represented 15.8% of the country's stocked forest area of 637,133 ha, and mixed forests (i.e. forests comprising 20% to 80% native species) 12.9%. This latter category overlaps considerably with the requirement applied during the National Survey of Native Woodlands, that each stand must have ≥50% native species to be included for surveying[1]. Mixed forests and non-native forests (i.e. forests comprising less than 20% native species) also encompass a wide variety of stand types, including naturally regenerating birch emerging strongly among planted conifers on a commercial reforestation site, and small areas and narrow strips of native canopy cover contained within older conifer plantations. While these areas cannot be considered as native woodlands as such, they do merit some level of inclusion as part of the overall native woodland resource within the country.

Native woodlands occur throughout Ireland but there is a concentration in upland areas of Wicklow, Waterford, west Cork and south Kerry, in parts of Clare and Galway, and on the Midland cutaway bogs. There is a scarcity of native woodland in landscapes with intensive agriculture. With a few exceptions, they are highly fragmented and most are small in size. Perrin *et al.* (2008) record that, of the 1,320 sites surveyed in the NSNW, "*The majority* [...] *were small or very small in extent, with 50% of sites being 6 ha or*

Ballykilcavan, Co. Laois. Ireland's native woodlands vary greatly in relation to area and distribution, species, woodland types, structure and ownership. This wood shows a well-developed structure with clearly defined tree and shrub layers.

less. Despite prioritisation of larger areas of woodland for field survey, over two-thirds (67.8%) of sites were 10 ha or less and only 3.3% of sites surveyed were 50 ha or more, with just ten sites over 100 ha" (also see Section B1 AREA).

Species

Ireland has a relatively poor vascular flora compared with Britain and the nearby Continent, and there are only *c.*30 species of native trees and shrubs. Typically, our native woodlands are dominated by just six species: sessile and pedunculate oak, ash, hazel, birch and alder, with willow often an important element. The principal species in the shrub layer are holly, hazel, sally and hawthorn. Small numbers of other trees and shrubs occur scattered among these species, e.g. rowan, crab apple, cherry, aspen, yew, spindle and guelder-rose. Native woodland stands often contain old trees of non-native broadleaf and conifer species, as recorded in 36% and 34% of those stands surveyed by the NSNW, respectively.

Dwarf shrubs are only represented by two species, bilberry and ling heather, both of which occur on acidic soils. Climbers are only represented by ivy and honeysuckle. In general, the herbaceous flora is very much richer, although it is relatively poor on acidic soils, where a limited number of species typically dominate, e.g. woodrush, bracken. A large variety of species occur on base-rich soils, including many familiar and colourful species, e.g. bluebell, anemone, primrose, bramble, meadowsweet. Ferns are common and often abundant in all woodlands.

In contrast to the vascular flora, the bryophyte and lichen floras are very species-rich. Ireland has one of the richest moss and liverwort floras in Europe, and some woodlands, especially in the west of the country, contain more species of these diminutive plants than flowering plants.

The impact of woodland fragmentation on species diversity is not entirely clear, but preliminary studies indicate that the larger the area of an individual woodland, the greater its species richness (C. Galley *et al.*, personal communication).

Woodland types

The NSNW (Perrin *et al.*, 2008) recognised four principal woodland types, based primarily on plant species assemblages. The nomenclature is derived from the dominant tree and herbaceous species, as follows:

- oak – woodrush (*Quercus petraea – Luzula sylvatica*)
- ash – ivy (*Fraxinus excelsior – Hedera helix*)
- alder – meadowsweet (*Alnus glutinosa – Filipendula ulmaria*)
- birch – purple moor-grass (*Betula pubescens – Molinia caerulea*).

These have been further subdivided into 22 subtypes. Some of these are distinctive enough to be considered as separate (if somewhat minor) woodland types, e.g. yew woodland, willow woodland and hazel woodland, the latter representing a significant subtype of the ash – ivy woodland type. Other subtypes are probably the product of past management practices rather than environmental and ecological drivers.

(Left) Fern croziers, St. Gobnet's Wood, Co. Cork.

*(Right) Orange grisette (*Amanita crocea*), Devil's Glen Forest, Co. Wicklow.*

Annex I of the Habitats Directive lists natural habitat types of Community interest whose conservation requires the designation of SACs. Annex I includes five woodland habitat types that occur in Ireland, as follows (the symbol '*' indicates a priority habitat type):

- old oak woods with holly and hard fern
- bog woodland*
- residual alluvial forests*
- yew woods*
- scrubby facies of limestone pavement*, which include (*inter alia*) hazel and ash.

The Habitats Directive Annex I woodland types do not always conform closely to the classification used under the NSNW. For example, while 'old oak woods with holly and hard fern' closely resembles the 'oak – woodrush' type, 'residual alluvial forests' comprises a variety of the 'ash – ivy' and 'alder – meadowsweet' subtypes. Meanwhile, 'yew woods' is a very clearly defined subtype of 'ash – ivy'. The relationships between the various native woodland classification systems used in Ireland are set out in Appendix 2, based on Cross *et al.* (2010).

Ireland's native woodland resource can also be classified into four major categories, based on the length of time that woodland has existed on the site.

- **Ancient woodland** is defined in Ireland as an area assessed as having been under woodland cover since 1660, based on the oldest reliable national records such as estate records and the Down and Civil Surveys[(2)]. Any woodland that appears on the 1st Edition 6 inch Ordnance Survey (OS) maps produced in the 1830s and 1840s should be considered as possible ancient woodland, unless there is evidence to the contrary. While it is very unlikely that continuity existed with the original primeval woodland, ancient woodlands are particularly valuable due to their biological significance as well as their historical and cultural importance.

Wetland wood with alder, Reen Wood, Killarney National Park, Co. Kerry.

- **Long-established (or old) woodland** is defined as an area that has remained continuously wooded since at least the 1st Edition OS maps of the 1830s and 1840s, but for which there is no positive evidence that it had been wooded for longer, or for which there is evidence that the woodland is not ancient.
- **Recent woodland** is defined as woodland likely to have originated since the 1st Edition OS maps.
- **New woodland** comprises broadleaf plantations dominated by native species and created in the last 20 years or so through the afforestation of open land, typically with support under various forestry programmes. These include sites afforested under the Native Woodland Establishment Scheme since its launch in 2001.

Bear in mind that some ancient or long-established woodland sites may have been planted with non-native conifer and / or broadleaf species in more recent times. However, these sites still retain their ancient or long-established woodland status, and many defining characteristics may still be evident.

The extent of ancient and long-established woodland in Ireland is not known. However, preliminary figures given by Perrin & Daly (2010) indicate a minimum area of 6,021 ha of ancient or possible ancient woodland, and 9,653 ha of long-established woodland. For further discussion, see Section B2: Ancient and Long-Established Woodland.

Structure

Native Irish woodlands typically have five vertical layers: the tree layer forming the canopy; the shrub layer, comprising shrubs and small trees; a dwarf shrub layer (present principally on acidic soils); the herbaceous or field layer; and the ground layer, comprising bryophytes. Where the canopy is low (for example, as in a hazel wood), occasional tall trees (or emergents) may protrude above the canopy. Climbers are rooted in the ground but can extend into the canopy.

Woodlands may also be broken up horizontally by clearings (both natural and artificial), roads and tracks, rock outcrops, and water features (ponds, streams, lakes, etc.). Some recently emerging woodlands – particularly on very steep slopes, in wetlands and on cutaway bog – appear to be unmanaged. However, most of our older native woodland stands are highly modified, although this may not be immediately apparent as they may not have been managed for many years. Old coppice, comprising dense stands of a uniform age, was recorded in 18% of those woodlands surveyed by the NSNW. Many sites are impacted by invasive species or inappropriate grazing, mostly overgrazing by deer or livestock, resulting in poorly-developed herbaceous and shrub layers and often very little natural regeneration. Where overgrazing has continued for a long period, the woodland may be very open with an over-mature canopy.

Woodland ownership

Most native woodlands in Ireland are privately owned, with a small but significant area managed by Coillte and the National Parks & Wildlife Service (NPWS). NPWS is responsible for *c.*4,570 ha of native woodland (in addition to some extensive areas of conifer plantations transferred from the former Forest & Wildlife Service). Of this area of native woodland, 2,628 ha are protected within 32 Nature Reserves and 2,854 ha within National Parks. Regarding native woodland under both private and public ownership, 6,468 ha are designated as SACs under the Habitats Directive, and 23,784 ha are identified as proposed Natural Heritage Areas (pNHAs) under national wildlife legislation. (Note, the above areas overlap and the figures presented are not cumulative.)

Most native woodlands owned by NPWS and Coillte have been managed to some extent over the last 30 years or so. The principal activities have been the removal of invasive non-native species, the removal of non-native conifers, and the control of grazing, mainly through the erection of deer fences and local culling. Coppicing has been re-introduced in a few locations, and educational / recreational facilities (e.g. paths, interpretive signage) have been installed at a number of sites (e.g. Ardnamona Wood, Co. Donegal). By providing additional support, the Native Woodland Scheme has also stimulated native woodland management on private sites since 2001. This has included the restoration of existing native woodlands through the removal of threats (e.g. rhododendron, overgrazing by deer) and restocking with appropriate native species, the conversion of non-native forest to native woodland (particularly on water sensitive sites), and native woodland afforestation on open greenfield sites adjoining existing woodlands and elsewhere within the landscape.

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[1] Stands surveyed as part of the NSNW had to satisfy the following criteria: area ≥1 ha; width ≥40 metres (or ≥20 metres along lakeshores and riverbanks); canopy height ≥5 metres (or ≥4 metres in the case of wet woodlands); canopy cover ≥30%; and ≥50% native species. Scots pine was regarded as a non-native species for the purposes of the survey.

[2] The first comprehensive maps of Ireland (the Down and Civil Surveys) were drawn up in the 1650s. After this date, the planting of new woodland was widely encouraged. Rackham (2005) draws attention to the fact that many woodlands depicted on these maps were missing from the later 1st Edition 6 inch Ordnance Survey maps, but that new areas had also appeared.

3. Planning and Management

Overview

The management of Ireland's native woodlands has been somewhat *ad hoc*, with no overall national objective other than the obligation on the State under the Habitats Directive to maintain the area and extent of the habitat, and where appropriate, to increase its ecological value. This shortfall is also reflected in the management of many native woodlands at a site level, leading to inappropriate practices that are sometimes out-of-step with the slow rate of change needed to conserve important ecological attributes. A more focussed, overarching strategy is required, as well as specific policies for different woodland types, both at a national level and for individual woodlands. The 5-year Strategy for Native Woodlands in Ireland published by Woodlands of Ireland (2016) is a welcome development in this regard.

National level planning and management

Under the Habitats Directive, the State is required to ensure that certain natural habitats of Community interest (as listed under Annex I of that Directive) are managed so that they achieve favourable conservation status. This applies not only to an Annex I habitat located within Special Areas of Conservation (SACs) designated for its conservation, but also to the entire national resource of that habitat. As set out by NPWS (2013), favourable conservation status is achieved when:

- the natural range of the habitat and the area it covers within that range, are stable or increasing;
- the ecological factors that are necessary for its long term maintenance exist and

A native woodland establishment site, Ballycoyle, Co. Wicklow. New native woodland on appropriate sites promotes biodiversity and habitat connectivity at a landscape scale, and delivers other valuable ecosystem services, including the protection of water and aquatic habitats and species.

are likely to continue to exist for the foreseeable future; and

- the conservation status of its typical species is favourable.

While it is not a legal requirement, the same objectives may also be applied to other, non-Annex I native woodland habitats, to ensure their conservation.

The most recent assessment of Annex I woodland habitats, undertaken as part of Ireland's mandatory reporting under Article 17 of the Habitats Directive (NPWS, 2013), found that, while bog woodland was largely in a favourable condition (Cross & Lynn, 2013a), the conservation status of old oak woodlands, residual alluvial forests and yew woods was either 'unfavourable–inadequate' or 'unfavourable–bad' (O'Neill & Barron, 2013; Cross & Lynn, 2013b). This was mostly due to:

- the presence of non-native invasive species;
- an inappropriate grazing regime;
- poor woodland structure; and
- a lack of natural regeneration.

The small size and fragmented nature of woodlands contribute further to their unfavourable status. While this appears to be a poor assessment, improvements in status since the previous assessment in 2007 (NPWS, 2008) were noted for the oak, alluvial and yew woodland types. Focused management since the 2007 assessment, stimulated by additional resources and initiatives, has led to the assignment of a positive trend. However, the relatively slow response of woodland dynamics often means that management inputs do not immediately translate into a better structure or enhanced regeneration. The above characteristics and trends are also evident in relation to non-Annex I woodland habitats.

Consequently, the principal national management objectives to improve the conservation status of all native woodland types should be as follows:

- to conserve native woodland habitats, associated species and genetic variation;
- to expand both the national area of native woodlands and the area of individual stands, in order to reduce fragmentation, enhance connectivity and increase the national resource;
- to improve woodland structure, including the creation and / or maintenance of open spaces;
- to maintain and improve species diversity;
- to encourage natural regeneration;
- to regulate grazing;
- to control invasive species; and
- to increase the quantity and variety of deadwood; and
- to encourage a greater understanding of, and appreciation for, Ireland's native woodlands amongst the wider public.

In order to achieve these objectives in the context of limited resources, effort should be carefully focused on the more important sites. A position regarding the conservation value of native woodlands has already been reached to some degree, in that Annex I

woodlands within SACs designated for their conservation are automatically considered to be of high conservation value. Woodlands within SACs but not of qualifying interest, or woodlands outside SACs, are of varied quality. They may be:

- high quality Annex I woodland habitats too small to be designated as SACs;
- old woodlands, as denoted by their presence on 1st Edition OS maps;
- high quality woodlands of non-Annex I habitat types, e.g. ash woodland;
- woodland stands of various habitat types and of medium to poor ecological quality; or
- stands of non-native conifers or non-native broadleaves.

At the very least, priority should be given to the management of ancient woodlands and also to the control of both invasive non-native species and overgrazing, two factors that probably pose the greatest threat to the long term survival of our native woodlands.

In attempting to restore native woodlands that may have been seriously impacted by inappropriate management or neglect, it is important to retain essential elements of the existing woodland environment. The existing levels of shade, humidity and shelter onsite are vital for many species of woodland flora and fauna, even if these attributes are being provided by a non-native canopy. The motto *make haste slowly* should therefore guide native woodland restoration and management. Continuous cover forestry (CCF) is highly relevant in this regard, as its application enables gradual change through the harvesting of single or small groups of trees and subsequent regeneration, while maintaining the overall canopy cover and woodland habitat conditions.

It is now well-recognised that the conservation of woodland species and ecosystems cannot be achieved within the boundaries of individual sites. Therefore, a strategic landscape-level approach is needed to achieve a critical mass of woodland cover, to target high value woodlands and to reduce fragmentation, particularly through the restoration of riparian woodland corridors and by reinforcing existing clusters of native

A soil core taken within woodland at Charleville, Co. Offaly, indicating a free-draining brown earth. Soil identification is a key part of native woodland planning and management, as it assists in identifying the most appropriate native woodland type and species to promote onsite.

woodland. In addition, this landscape approach will be more effective in realising other ecosystem services that existing and new native woodlands can 'deliver', such as the protection and enhancement of water quality, flood mitigation, climate change mitigation, landscape enhancement, and cultural services such as outdoor amenity and environmental education. This requires an ongoing partnership between the native woodland 'sector' and various other bodies not directly connected with native woodlands but with an obvious interest in the ecosystem services they deliver, e.g. local authorities, Inland Fisheries Ireland, the Environmental Protection Agency. Encouragingly, such partnerships are emerging in Ireland, under the auspices of Woodlands of Ireland and in other forums, and in the context of the Water Framework Directive.

Finally, the realisation of wood and non-wood products is often an essential component of native woodland management. This is particularly critical for many private landowners who may wish – or indeed demand – some sort of economic return from their woodlands. In many cases, through the application of CCF, this objective is compatible with the conservation of woodland biodiversity, and can provide the basis for the long term sustainability of the such habitats, as demonstrated by the Coed Cymru organisation in Wales.

Underpinning all of the above is the involvement of the landowner, who represents the most critical link in the chain. It is important to assess his or her requirements and preferences, and to ensure that supports aimed at achieving the above objectives and prioritisations are fit for purpose.

Site-level planning and management

General considerations

In general, native woodland management in Ireland falls into one or more of the following overall approaches:

- Native woodland conservation, whereby the woodland is already in a relatively natural state, and where interventions are largely limited to monitoring and necessary follow-up action to tackle any emerging threat.
- Native woodland restoration, whereby threats of various types and severities are tackled to return the woodland to a more natural state. Such threats can include rhododendron infestation, overgrazing by deer and the presence of seeding beech or sycamore, or structural deficits such as the over-dominance of a single species and older age classes, which may prompt the creation of coupes. Woodland restoration may also apply whereby traditional forms of woodland management, such as coppicing, are being reinstated.
- Expansion, through either: (i) afforestation with new native woodland on open land; or (ii) the conversion of existing non-native forest to native woodland, through gradual transformation (using CCF) or abrupt replacement (using clearfelling and reforestation with native species).

As deemed appropriate, each of these approaches may also entail additional objectives, including compatible wood production and the delivery of wider ecosystem services, such as habitat linkage, the protection of water, and landscape and amenity.

Rowan berries, Coillte's Ballintemple Nursery, Co. Carlow. All forest reproductive material used in native woodland afforestation or restoration should be derived from suitable sources within Ireland, and be fully traceable from seed collection to the planting site.

The following sets out general guidance regarding planning and management that relate to native woodlands at an individual site level. These should be considered in parallel with the detailed guidelines on specific topics and native woodland types, set out in Parts B and C.

1. It is essential to have in place a tailored long term plan for the woodland, based on a detailed assessment of its ecology (including threats) and silvicultural parameters (canopy composition, potential for natural regeneration, etc.). The plan should set out short, medium and long term objectives and a rolling 5- to 10-year schedule of operations setting out what needs to be done each year to steer progress towards achieving those objectives.
2. The plan should be drawn up, implemented and monitored by an experienced woodland ecologist working alongside a professional forester knowledgeable in close-to-nature silviculture and a forest contractor well-versed in working on sensitive sites. Each professional brings complementary skill sets that together will identify the most suitable and appropriate interventions to make.
3. Where the conservation value of a particular native woodland is not already known, an assessment is required in order to ensure that the woodland habitat is correctly managed in a way that maintains or improves its conservation status. An examination of the flora and woodland structure will provide considerable information and should be the first step. All available information on the fauna should also be collated. Ideally, an assessment of the site for mammals, birds and invertebrates should be undertaken, although information on invertebrates may be poor or non-existent. Rare and protected habitats and species within the site should be noted. The proximity of the woodland to other wooded sites should also be considered, as woodlands that form part of a woodland complex (even of coniferous stands) tend to be of higher ecological value than isolated sites. If possible, the history of the site should be established, to ascertain if it is an ancient or long-established woodland site.

Native woodland conservation, restoration and expansion require the combined input of ecologists and foresters working closely with landowners, and supported in their efforts by relevant public bodies and eNGOs. Joint Forest Service / Woodlands of Ireland training, Ballycoyle, Co. Wicklow.

Such sites require particularly sensitive management in order to protect their inherent ecological value.

4. The overall objectives of management should be to enhance the woodland's conservation value and to control the impact of threats such as rhododendron and unsustainable grazing, in order to create suitable conditions for the woodland to evolve naturally in a robust and viable manner, following its own course.

5. Native woodlands are robust ecosystems that can withstand a considerable amount of human intervention and disturbance. They can also survive long periods of neglect. However, while individual trees may live for hundreds of years and can survive a variety of changes, other organisms may be much more sensitive and vulnerable to change, particularly sudden change. Consequently, management should avoid drastic changes that can disrupt the woodland ecosystem, and to ensure that activities undertaken to improve the site from a conservation perspective do not unwittingly cause irreparable damage. For example, where stability allows, the gradual transformation of a non-native stand to a native stand, using CCF, is far better than sudden replacement through clearfelling and reforestation, as the woodland habitat and associated micro-climatic conditions are preserved throughout the conversion process. For this reason, CCF systems such as coppicing, shelterwood and selection are central to native woodland management.

6. Native woodland management tends to focus principally on the trees and other vascular plants – shrubs, herbs and ferns. However, native woodlands are also of great importance for bryophytes (mosses and liverworts) and lichens, as well as for fungi, invertebrates, birds and mammals. Management objectives should take all of these groups of organisms into account. In some instances, they may be of overriding importance, e.g. certain breeding bird species or rare lichens.

7. Desired changes can be realised using management 'tools' that encompass a wide range of operations. These include (*inter alia*) the felling of individual

or small groups of trees, thinning, clearfelling, restocking beneath an existing canopy, reforestation after clearfell, afforestation on open sites, managing for natural regeneration, coppicing, the control of grazing, the creation of ridelines and other open spaces, the removal of invasive exotics and non-natives, and deadwood creation.

8. Quality hardwood production realised using CCF can be a compatible co-objective alongside conservation on many native woodland sites. Realising this potential links native woodlands to owners' livelihoods and to local economies, and is an important factor in securing the future of these habitats.
9. Objectives relating to the delivery of other ecosystem services may also be an important consideration on many sites, particularly those in sensitive landscapes such as National Parks and the catchment areas of high status objective waterbodies, where the creation of wider habitat linkages and the protection of water and associated aquatic ecosystems and species will be highly relevant.
10. The longevity of trees and the relatively slow rate of change and natural replacement within woodlands dictate that management plans, while unlikely to have an operational duration of more than 10 years, do require a vision extending much further, perhaps as much as 50 years. This presents challenges in terms of maintaining a consistent policy and a cohesive approach, given that several managers may be involved over the plan's lifetime, each overseeing different intervals. Therefore, the management plan should be as clear and as straightforward as possible, and also flexible and robust, to allow for changes in organisational structures, economic conditions and advances in knowledge. Not least, it should take account of natural changes within the woodland itself, as opposed to forcing hard-and-fast ideas regarding woodland type and structure.
11. Management actions should be recorded, and such records carefully retained. Records (including detailed maps and fixed point photography) are essential in order to understand changes within the woodland, and to facilitate monitoring

New native woodland and accompanying water setbacks create permanent semi-natural buffers that protect and enhance water quality and promote ecological connectivity in the landscape. Woodland with setback at Ballyvary, Co. Mayo, established in the early 2000s.

over many years. Individual managers come and go and even the best memory is faulty. In effect, unless there is a written record, activities will be forgotten. These records should be in both paper and electronic format, to guarantee as far as possible against loss. The general lack of information on the historical management of our native woodlands, and the value of those records that do exist, underline the importance of record keeping.

12. Woodland management can be expensive in terms of both time and resources, although this can be offset to some extent by the availability of supports (such as the Native Woodland Scheme) and once-off or ongoing revenue from the sale of timber and other products, both wood and non-wood. Resources for the micro-management of sites are generally not available and some landowners may not have the interest or facilities to implement detailed and complicated management plans.
13. Threats to Ireland's woodlands and forests can arise in the form of newly introduced pests and diseases. Therefore, early detection is essential. Woodland owners, ecologists and foresters are encouraged to be vigilant in detecting such introductions. If any unusual pest or disease is observed or any unusual symptoms or ill-health noted, please immediately contact the Forest Service, Department of Agriculture, Food & the Marine (e-mail forestprotection@agriculture.gov.ie / tel. 01-607 2651). Interested parties are referred to www.agriculture.gov.ie/forestservice/treediseases/ for information on diseases of concern.
14. In addition, it is good forest practice to follow a clean entry and exit policy, whereby soil and vegetation debris are vigorously cleaned from footwear, clothing, tools, equipment and machines. This will not only help protect against the entry and spread of pests and diseases, but will also help prevent the spread of invasive exotic species, for example, where seed is transferred *via* hiking boots or bike tyres. Readers are advised to research good practice in biosecurity and sanitation measures (including suitable disinfectants) appropriate to managing the potential risks of tree disease, pests and invasive species that may affect woodland under their care.

Further guidance on the development of woodland plans is set out in Collins *et al.* (2010) and within the supporting documentation for the Native Woodland Conservation Scheme (DAFM, 2015a).

Legislation governing nature conservation, forestry activities and wider environmental protection must be considered during the planning stage, before any woodland management activities take place. This is vital within the context of native woodlands, due to the significance of many sites at a national, European and international level. Many activities within designated woodlands require legal consent from the National Parks & Wildlife Service (Department of Arts, Heritage, Regional, Rural & Gaeltacht Affairs). Also, certain habitats and species are legally protected under various legislation, regardless of where they are found. Similarly, licences are required from the Forest Service (Department of Agriculture, Food & the Marine) to undertake various forestry activities such as afforestation and tree felling. Readers are directed to online information available at www.npws.ie and at www.agriculture.gov.ie/forestservice for details.

Projects submitted under the Native Woodland Scheme or any other Forest Service

scheme must meet the terms and conditions of that scheme, and any variation must be agreed in advance with the Forest Service.

Detailed guidance

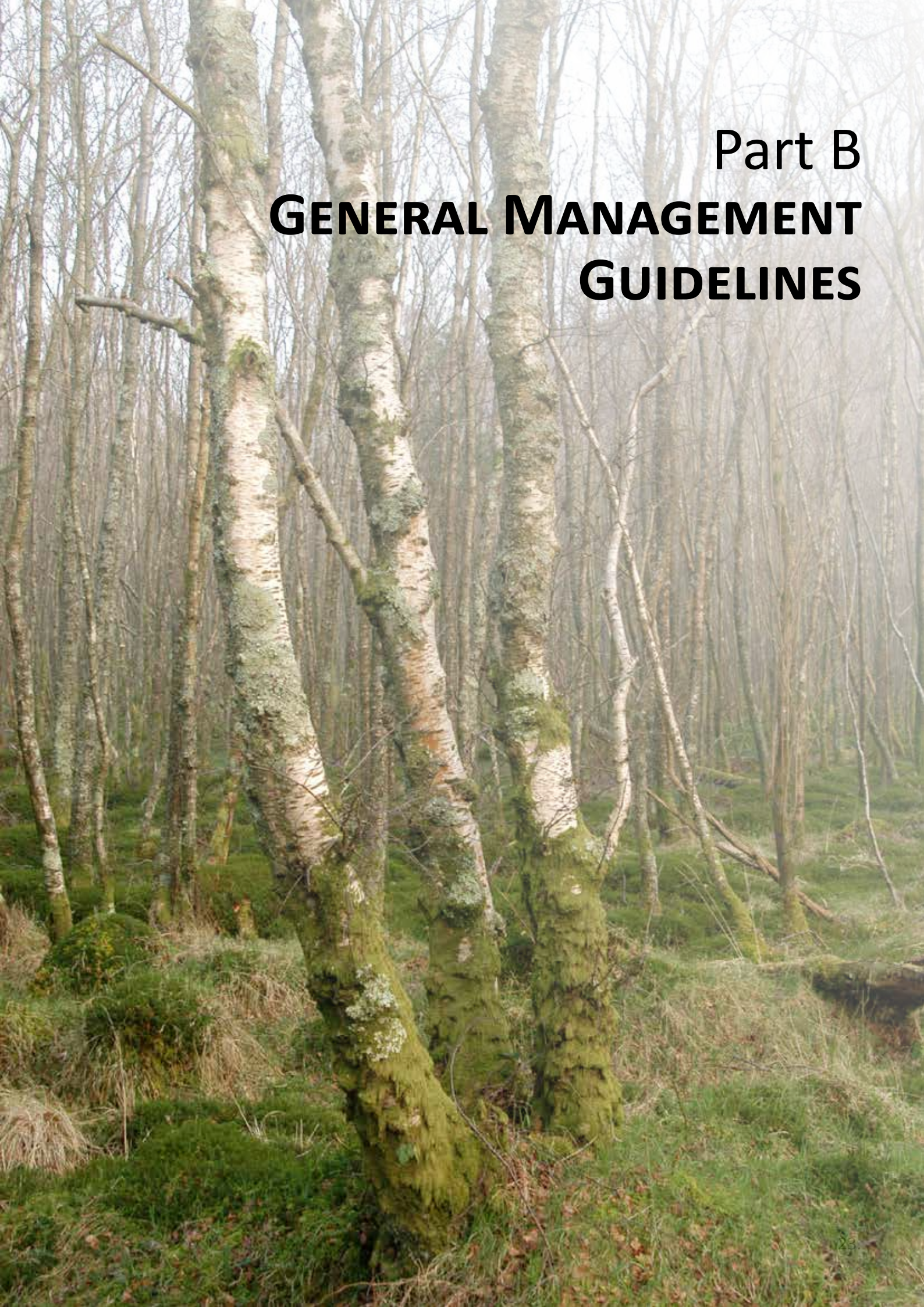
More detailed guidance on native woodland management is contained in Part B and Part C of this manual. Part B contains guidelines structured around 11 relevant topics, e.g. 'Area', 'Grazing', 'Expansion' and 'Products'. For each topic, objectives are identified, followed by an overview, management guidelines and examples of good practice. Part C contains guidelines for specific woodland types in Ireland, e.g. Oak (*Quercus petraea*) Woodland, Hazel Woodland, Alluvial Woodland. It provides a brief description of each type, together with specific management guidelines.

Part B and Part C, together with the above section exploring overall considerations, address native woodland planning and management at a site level. Further resources are included as appendices, in the form of a species list, an overview of native woodland classification systems used in Ireland, a reference list and a glossary of terms relating to native woodland ecology and management generally, as used here and elsewhere.

The guidance contained in these *Management Guidelines for Ireland's Native Woodlands* draws on the knowledge and experience gained over the last 15 years from a wide variety of native woodland initiatives undertaken in Ireland, particularly those set out in Section A1: INTRODUCTION. It also draws on the works of various Irish and UK woodland ecologists, foresters and other experts, such as Peterken (1993 & 2002), Rodwell & Patterson (1994), Kirby & Morecroft (2000), Rackham (2003), Kirby *et al.* (2005), Little *et al.* (2009), Cross *et al.* (2010) and Bullock *et al.* (2014). It attempts to cover all key aspects of native woodland management but does not claim to be comprehensive, referring the reader instead to more detailed sources, where available.

The guidance set out in these *Management Guidelines for Ireland's Native Woodlands* is advisory only, and the specific characteristics of each individual native woodland, together with any legal or grant requirements that may apply, will dictate the initial context for any plan. However, it is intended that the information contained in this manual will assist owners, ecologists and foresters to arrive at the most appropriate 'solution' for individual woodlands, suitably balancing conservation with wood production and other objectives, and realising these objectives at an appropriate rate of change, using compatible approaches and techniques.

Such solutions will enable Ireland's native woodlands to develop as robust, dynamic and sustainable ecosystems, and as net contributors – environmentally, economically and socially – to our daily lives.



Part B
General Management Guidelines

1. Area

Objectives:

- ***ensure that the area of individual stands of native woodland is stable or increasing;***
- ***ensure that the overall area of native woodland in Ireland is stable or increasing;***
- ***reduce fragmentation; and***
- ***increase connectivity.***

Overview

Size is an important attribute of woodlands as it has a major influence on the diversity of habitats and species. Most Irish native woodland stands are small and often too small to support species requiring a large territory. Of the 1,320 sites surveyed in the National Survey of Native Woodlands, 50% were 6 ha or less and only 3.3% were 50 ha or more (Perrin *et al.*, 2008). Very few sites surveyed exceeded 100 ha.

Peterken (2002) emphasises that open spaces within a woodland, such as rides, clearings and watercourses, are critical for supporting a wide range of biodiversity. A 'large wood' "*must be large enough to maintain a normal age-class distribution, minimise edge effects, and support large-territory species*". He cites evidence that 25 ha is a critical size for woodland plant species associated with open spaces and for certain bird and mammal species. This size also seems to be critical for the persistence of permanent open spaces as management features. In terms of small woodlands, 3 ha appears to be a critical size, as below this limit, woodlands rarely contain permanent open space. Consequently, where the objective is to expand a woodland, 25 ha should be considered as the minimum target area for larger woods, and 3 ha for small

Killarney National Park in Co. Kerry contains the largest area of native woodland in the country. It sustains a wide range of plant and animal species that require extensive areas of native woodland. (Photo DAFM)

woodlands. Also see Section B3: STRUCTURE.

At a landscape scale, the most important consideration in terms of native woodland expansion is to reduce fragmentation and to provide connectivity for species between woodlands and other semi-natural habitats within the surrounding area. Analyses show that 30% woodland cover within the landscape is a critical threshold – for most woodland species, this is the minimum proportion at which the landscape begins to function as a single, large wood (Peterken, 2002). Large native woodlands incorporating existing semi-natural features such as hedges, streams and fens should be developed, as they often retain a reservoir of woodland species. Watercourses are particularly valuable as corridors for the movement of species. Ideally, new woodland should be positioned adjacent or close to existing native woodland, in order to maximise colonisation by woodland species. This process, however, can be very slow for some species.

Given the size and distribution of native woodlands in Ireland, it will be difficult to achieve these targets regarding size and woodland cover. This, however, may be possible within some of our larger SACs and proposed NHAs and where native woodlands adjoin conifer plantations. A good example is found in the Woodford area of Co. Galway, where several native woodlands, including the Derrycrag (110 ha), Pollnaknockaun (39 ha) and Rosturra (18 ha) Nature Reserves, are embedded within an extensive forest area.

In the context of limited resources, emphasis should be placed on expanding individual woodlands within existing forest matrices, rather than creating or expanding isolated woodlands in landscapes that are largely agricultural in nature. Suitable areas include, for example, parts of Waterford, east Wicklow, southwest Cork / southwest Kerry, central Clare / southeast Galway and northeast Donegal, where there are already significant concentrations of native woodland. An exception should be made for isolated ancient woodlands, the boundaries of which should be expanded, where possible.

The expansion of native woodlands can be achieved by native woodland afforestation on greenfield sites or by converting non-native conifer, broadleaved or mixed stands to native woodland. Where practicable, the latter is the preferred option. This is

Uragh Wood, Co. Kerry, an ancient woodland forming a striking landscape feature. Stands of aspen, with reddish leaves, occur near the lakeshore. Recent planting has expanded the area of native woodland in this locality.

because woodland habitat conditions already exist and a native woodland ecosystem is likely to emerge far quicker and more successfully than on greenfield sites, where high soil fertility, dense grass cover and the paucity or absence of tree mycorrhizae often inhibit colonisation by native woodland plants. Areas of existing conservation or environmental significance relating to water, such as freshwater pearl mussel catchments or the catchment area of high status objective waterbodies, should also be targeted strategically, to utilise the potential of native woodlands to deliver important ecosystem services, including the protection of water against nutrient and sediment run-off from other land uses.

While native woodland afforestation on greenfield sites remote from existing native woodlands is less than ideal, it should not be dismissed. Although colonisation by certain woodland species can be very slow, the new woodland will eventually develop its own natural ecosystem and may become the nucleus for a larger and more significant native woodland in the future. See Section B9 AFFORESTATION for details.

Management guidelines

- Native woodlands can be expanded and amalgamated by afforesting adjacent greenfield sites with new native woodland, and by converting adjacent non-native woodland (including conifer forest) to native woodland. This can be carried out provided it does not damage other habitats or species of conservation value.
- Expansion (both afforestation and conversion) should be focused on sites beside and nearby possible ancient or long-established woodlands.
- Aim to create native stands that are no smaller than 3 ha in area, and to expand larger woodlands above the 25 ha threshold. Adopt a landscape approach and attempt to form blocks of native woodland incorporating other semi-natural habitats.
- Small stands (i.e. less than 1 ha) of non-native species within an existing native woodland matrix should be either: (i) clearfelled to produce clearings for possible reforestation *via* planting and / or natural regeneration; or (ii) if in a sensitive location and windfirm, gradually thinned out or even ring-barked, to allow for the gradual colonisation by native species. Any native trees left exposed during this process and in danger of being windthrown, should be pollarded.
- Conifer plantations can be considered part of a woodland matrix as they aid continuity of cover for more mobile species. However, in general, they do not provide suitable habitat for more demanding or specialist native woodland species, and where possible, their conversion should be considered. A distinction should be made between the dense canopy of a species such as Sitka spruce, and the open canopy of larch or Scots pine, which often allows a well-developed herb layer to emerge. Advice from a forester is required regarding canopy density, light management, wind stability, felling operations, extraction techniques, etc.
- Existing native woodlands should not be reduced in size, unless there is an overriding conservation reason for doing so, e.g. if woodland cover has recently

expanded into another habitat of ecological importance and which could be successfully restored.

Examples of good practice

- Ballyvary, Co. Mayo: New woodland planted in 2002 adjacent to existing hazel and alluvial woodland.
- Derrybawn, Wicklow Mountains National Park: Large conifer stands felled and reforested with native woodland, thereby expanding woodland cover and reducing the fragmentation of areas of existing woodland.
- Vale of Clara Nature Reserve, Co. Wicklow: Fragmented native woodland restored to a large stand (>200 ha) of native woodland through the gradual removal (over *c.*20 years) of conifers and by facilitating the natural regeneration of native species.
- Ballykilcavan, Co. Laois: A privately owned mixed forest located on a probable ancient woodland site, and where continuous cover forestry is being used to gradually replace conifers with native species.

2. Ancient and Long-Established Woodland

Objective: Ensure that ancient and long-established woodlands achieve, and are maintained at, favourable conservation status.

Overview

Superficially, ancient and long-established woodlands may not appear very different from other woodlands, and documentary records may be the clearest evidence of distinction. However, biological indicators are often present. For example, these woodlands tend to be dominated by oak and / or ash, with alder and birch woodlands in general being more recent in origin. Also, they often contain a suite of herbaceous species that are uncommon on more recent woodland sites (e.g. wood anemone, sweet woodruff), as well as species that are rare and very localised (e.g. toothwort) (Perrin & Daly, 2010). The lichen flora and invertebrate fauna may also contain significant and rare species, although there is less information on these species groups. Furthermore, for a given size, ancient woodlands have significantly more vascular plant species than more recent woodlands. It is important to note that some ancient and long-established woodland sites may now be dominated by recently planted conifers or may exist as individual stands within larger forest holdings.

Intact ancient woodlands are irreplaceable. Consequently, they should be considered as living national monuments, and management should be undertaken in a highly sensitive manner.

Some ancient and long-established woodlands have been greatly compromised by the planting of conifers or non-native broadleaves since the early 20th century. Apart from the direct damage caused by the initial felling and replanting, further damage arises

Bluebell sward at St. John's Wood, Co. Roscommon, an ancient woodland with a remarkably rich tree and shrub flora.

from changes in the light and moisture regimes, and litter deposition. Nonetheless, some of the original woodland species may have survived through to the present day, and management should aim to restore such stands over a time scale involving several decades, using continuous cover forestry. Methods for restoring ancient woodland sites are detailed in Pryor *et al.* (2002). Elements of Section B10 CONVERSION also apply.

Ancient and long-established woodlands, by definition, cannot be expanded. However, the creation of new native woodland on adjoining sites, either through afforestation or conversion from non-native forest, will provide protection and will eventually create conditions into which adjacent woodland species might migrate. Regarding woodland expansion, see Sections B9 AFFORESTATION and B10 CONVERSION.

Management guidelines

- Consider any existing woodland that appears on a 1st Edition OS map as being potentially ancient or at least, long-established. Also, consider any existing woodland that appears on records dating back to 1660 as being ancient. If possible, try to confirm the age of the site through the examination of appropriate maps, estate records and other published data (e.g. locally derived pollen diagrams), and by studying the flora and the invertebrate fauna. The Woodlands of Ireland Information Note 1 (*Cartographic and historical sources for native woodlands*) and Information Note 2 (*A history of woodland management in Ireland: An overview*) (Byrnes, 2007a & 2007b) are highly relevant in the identification of these woodlands.
- Due to their unique status, ancient and long-established woodland should be prioritised during resource allocation, planning and management. Where management inputs are needed to achieve or maintain favourable conservation status, the focus should be on minimising disturbance. In particular, avoid the removal of old trees and coppice stools, soil damage (including compaction), and the disturbance of historical woodland management artefacts such as saw pits and charcoal hearths.
- As a priority, address factors that pose an acute threat to the woodland ecosystem, such as rhododendron infestation or unsustainable grazing by deer.
- If required, the removal of non-native trees should be carried out very carefully and gradually over time using CCF, in order to maintain woodland conditions throughout the process. The gradual transformation of conifer stands can be achieved by thinning out the overhead canopy over time, to facilitate the emergence of young native trees beneath, originating from planting and / or natural regeneration. (Note, however, that the risk of the original stand becoming windthrown may rule out this approach.) If dealing with non-natives distributed throughout a stand, eliminate these over time through single tree or group selection. At all stages, take cognisance of the ecological risk of any natural regeneration arising from non-natives.
- Regarding the removal of non-native trees, priority should be given to tackling seed-producing trees of those species capable of producing viable seed. Seed-producing trees can be identified by their age, state of maturity or crown size. An exception to this rule may apply if the trees involved – e.g. Norway spruce, Douglas fir – are supporting local populations of red squirrel.

Toothwort, a parasitic species and an indicator of long-established or ancient woodland.

- Regenerate old coppice woodland, provided that the stems are not too old and can still form viable coppice stools. (Also see Section C5: HAZEL WOODLAND.)
- Wood production within ancient and long-established woodlands should be secondary to conservation and should only be sought where it forms an integral part of maintaining or restoring habitats. For example, the realisation of wood products from a coppice stand is an integral part of maintaining coppice woodland and its associated biodiversity. Similarly, timber realised from the removal of non-natives should be regarded as a 'by-product' of restoration works, and not an end in itself. See Section B11 PRODUCTS.
- Very sensitive areas, such as wet flushes, springs and streams, should remain undisturbed, unless their integrity is being threatened, for example, by rhododendron or Japanese knotweed.
- Retain refuge areas for animal life within the woodland. For example, veteran and / or moribund trees provide habitats for rare invertebrates, rot holes for bats, etc.
- Rare species of vascular plants (e.g. toothwort), epiphytic lichens and bryophytes should be left undisturbed. Specialist ecological advice may be required to identify these species and their associated communities, and their degree of sensitivity regarding any proposed management interventions.
- Where possible, create new native woodland on the periphery of ancient and long-established woodlands, to expand woodland cover and to put in place a protective buffer in relation to surrounding land uses and associated influences.

Examples of good practice

- Glengarriff Nature Reserve, Co. Cork: Sensitive removal of rhododendron and conifers.

- Ballyar Wood Nature Reserve, Co. Donegal: Carefully managed woodland, with small areas coppiced to diversify canopy structure.
- St. John's Wood, Co. Roscommon: Small areas coppiced to restore former management and to diversify structure.
- Charleville Wood, Co. Offaly: A privately owned woodland managed for timber production and the control of deer and invasive non-native plants.
- Ballykilcavan, Co. Laois: A privately owned ancient woodland in which refuge areas have been retained while confers are being gradually removed for timber in order to restore native woodland.

3. Structure

Objectives:

- ***ensure a diverse structure with a relatively closed canopy containing some mature trees and well-developed understorey, shrub, herb and ground layers, including old growth stands;***
- ***maintain the diversity and extent of plant community types; and***
- ***maintain or create areas of open space to provide a diversity of habitats and species.***

Overview

Woodland structure may be considered at two levels: vertically, i.e. the canopy, understorey, shrub, herb and bryophyte layers; and horizontally, i.e. the varying density of trees, the presence of clearings, etc. The physical structure of a woodland is the function of a wide range of influences, including:

- site factors such as soil, elevation and exposure;
- the age and size of the stand;
- the age and size of the trees and shrubs within the stand;
- natural events such as windthrow and grazing;
- previous and current management; and
- woodland dynamics over time.

Even-aged stands appear to be the rule rather than the exception, even in unmanaged forests (Peterken, 1993), typically arising from short periods of regeneration following

A well-structure oak wood with good regeneration and a luxuriant herb layer.
Ardnamona Wood Nature Reserve, Co. Donegal.

disturbance. Maintaining a diversity of age classes among the trees in any one stand, therefore, is less important than maintaining diversity between stands. In addition, in many oak-dominated abandoned coppice-with-standards woodlands, regeneration is severely lacking. This is due to the limited opportunity for light demanding species – which account for most of Ireland's trees and shrubs – to become established. For further information, see case studies for sessile and pedunculate oak in Little & Cross (2005).

In general, the larger and older a woodland is, the more diverse the structure is likely to be, as previous management practices and natural events (such as windthrow and tree death) lead to a structural mosaic. Such woodlands may require no further diversification of their structure. Species are also a key driver of structural diversity. Oak (and to a lesser extent, ash) shows a greater range of size and age classes (from establishing regeneration through to very old, and sometimes ancient, specimens) but has a lower rate of turnover than birch or alder, which are smaller and shorter lived. If allowed to develop undisturbed, the species composition of the canopy may change over time, possibly on a cyclical basis (e.g. ash replacing oak). However, the dominance of certain species, especially oak, in many native woodlands is often a product of previous management. Consequently, it is not necessary to strive to maintain the current dominant species if another native species appears to be replacing it, unless the other species is being given a dramatic and undue advantage due to artificial factors.

The more diverse the woodland structure is, the greater the biodiversity and hence, the woodland's conservation value. Rare and critical species may depend on structural diversity, particularly the presence of old trees that may have rot holes and dead and decaying branches. Some species require very specific habitats. For example, some invertebrates require large trees with rot holes, while a continuity of micro-habitats over time is important in order for certain lichens to survive. The sheltered interior of woodlands is particularly important for some species. Here, the edge influence peters out, conditions are normally darker and damper, and micro-climatic variations are less. Such areas are valuable for certain invertebrates, fungi and birds. Inappropriate

A small Molinia *fen in spring within a mixed oak-ash-alder wood provides open, sheltered habitat. Co. Galway.*

management may result in the destruction of these habitats and disruption of associated species.

Old growth stands are areas in which trees are allowed to complete their full life cycle, from seedling to old age, death and decay. This process may take hundreds of years, particularly with slow growing species such as oak. The structure within such areas varies over time, from a dense thicket of young regeneration to a relatively open state in which old and moribund trees dominate the canopy, with regeneration developing underneath. Characteristically, there are large quantities of deadwood. Many of our older woodlands are in the 'ageing' or 'mature' phase in which the canopy is dominated by old and often 'stag-headed' trees. In theory, regeneration should also be occurring, but this is often absent, due to overgrazing and insufficient light levels on the forest floor. Old growth stands are particularly valuable for invertebrates, fungi and other micro-organisms that require old trees and decaying wood. Intervention should be minimal, except for the control of invasive non-native species and excessive grazing.

Open habitats within woodlands – such as small grassland and wetland areas, streams, lakes, forest roads, tracks, ridelines and clearings – are important elements and provide habitats for a variety of plants and animals that are light demanding and / or prefer more open, sunny and warm conditions. They also encourage flowering plants, which in turn attract nectar-feeding species, and provide habitat for edge species and flight lines for invertebrates, birds and bats. In recent years, the value of these woodland-based open habitats has increased with the intensification of agriculture and the associated loss of semi-natural habitats in the wider countryside. In some areas, they may be the only permanent open, semi-natural habitats within the landscape. Where practical, these open habitats should be left intact and managed to retain their biodiversity value. For example, edge management can be applied to promote a gradual transition from ground vegetation to the woodland canopy. Cutting vegetation at different heights alongside tracks and ridelines also creates further habitat diversity.

Woody growth often occurs within open spaces, through natural regeneration arising from the adjoining canopy. While representing a natural process, this threatens the

An over-mature, open woodland with stag-headed trees and deadwood, and with little or no regeneration evident.

A wet hollow with standing and fallen deadwood, Charleville, Co. Offaly.

long term retention of structural open spaces, particularly where the size of the overall woodland limits the scope to allow natural processes 'free reign'. Cutting woody growth within open spaces (typically with a brush-cutter) is very expensive in terms of time and resources, and also fails to emulate grazing, but may be the only practical method on many sites. However, if possible, consider periodic grazing, *but only on a strictly controlled basis and for limited periods of time*. Within grant aided projects (including those supported under the Native Woodland Scheme), this approach must be agreed in advance with the Forest Service.

In order to avoid the destruction of sensitive habitats and over-fragmentation of the canopy, the creation of new open habitats within existing native woodland needs to be carefully considered. Woods less than 3 ha may be too small to contain more than one or two structural open space units. Where this is the case, they should not be fragmented any further, and the focus should be on woodland expansion. Where there is an even-aged stand of young trees in a small woodland (for example, due to a previous clearfell or an extensive windthrow event, or the woodland's origin as a grant aided plantation), structural diversity may be created by thinning or by creating small coupes. In a large woodland, however, this is unlikely to be necessary.

Open spaces can be transient and yet still provide valuable structural diversity. For example, the replacement of a stand on non-natives within or adjacent to a native woodland will create a temporary open space while the new native woodland canopy becomes established.

When planning new native woodlands (either through afforestation or conversion), incorporate any notable biodiversity features already present onsite, such as wet hollows, streams and rock outcrops. Environmental setbacks from (for example) streams, archaeological features and adjacent dwellings, and open spaces left unplanted for management features such as ridelines and tracks, are also important. Under the Native Woodland Establishment Scheme, 10-15% of the site must be treated as so-called 'Areas for Biodiversity Enhancement', to retain existing habitats and to create open spaces within the new woodland (DAFM, 2015b & 2016). All of these open spaces

should be wide enough to ensure that they remain open to sunlight as the adjacent trees increase in height. Consideration should be given to their orientation, as this will influence the amount of sunlight received and subsequent habitat development. Furthermore, capitalise on opportunities to tie in planned open spaces with habitat features adjoining the site, such as hedgerows, wet hollows and semi-natural grassland, even if such features are on a separate property.

Management guidelines

- Where appropriate, manage for diversity in both the vertical and the horizontal structure, but not at the expense of existing valuable habitats.
- Minimal intervention areas should be left unmanaged, unless there is some overriding reason to intervene. Such areas range in size, from small areas within woodlands to entire woodlands set aside solely for conservation purposes.
- Some stands, especially those within Nature Reserves and National Parks, should be allowed to develop into old growth stands through minimal intervention.
- Even-aged stands of native woodland greater than 5 ha could be opened up or thinned out to diversify their structure, where this would benefit biodiversity and is compatible with other objectives. The width of any coupe created should be relative to the height of the surrounding canopy and should be no greater than 0.2 ha in area. If considering this option, bear in mind the increased risk of windthrow and whether or not the appropriate light levels required for natural regeneration can be achieved.
- Within large woodlands (>25 ha), ensure that sufficient areas of 'interior' habitat are retained.
- Small woodlands (<3 ha) should not be unduly fragmented through the creation of ridelines, tracks and other open spaces. Instead, diversity can be created by applying continuous cover forestry and by focusing on expansion, where possible.
- Retain individual specimens and stands of old, moribund and dead trees.
- Retain open habitats within the woodland, such as small grassland and wetland areas, ridelines and other woodland clearings. Where possible, manage these areas for biodiversity. Consideration should be given to expanding the width of ridelines and tracks.
- When controlling woody growth within open spaces, favour carefully controlled grazing over manual cutting, if possible.
- Intersections where different open spaces meet can be expanded to create larger clearings.
- Within areas alongside the woodland edge, cut the vegetation at various heights and incorporate different sized trees and shrubs.
- Old quarries, cuttings, rocky outcrops and stone walls should be kept open to available sunlight, particularly those that are south-facing.
- If establishing new areas of native woodland, planned ridelines and glades

should be wide enough to avoid shading as the canopy grows. The width should be at least 1.5 times the eventual height of adjacent trees. Favour an east-to-west alignment, where possible.

Examples of good practice

- Vale of Clara Nature Reserve, Co. Wicklow: This large woodland contains a variety of structural elements arising from previous management and the felling of inter- and under-planted conifers. Some stands of even-aged oak have been thinned out to open up the canopy. Margins of tracks are cut to retain open areas.
- Ballyar Wood Nature Reserve, Co. Donegal: Open areas have been created by coppicing small areas.
- St John's Wood, Co. Roscommon: This large, ancient and very species-rich woodland was formerly coppiced and now has a uniform structure. Small areas have been coppiced to create open spaces.

4. Species

Objective: Maintain typical as well as rare native species of flora and fauna and their associated habitats, as appropriate for each specific native woodland type.

Overview

Species occurring in woodlands may be classified as woodland specialists, woodland generalists and ruderals (or opportunists). Of greatest value are the woodland specialists, although with greater pressure on other habitats, generalists may become increasingly important. Woodland specialists are species that require very specific conditions which are only provided by woodland environments. They include species characteristic of ancient woodlands referred to in Section B2: Ancient and Long-Established Woodland, e.g. anemone, toothwort. Woodland specialists are very sensitive to habitat changes and are very easily lost by inappropriate management.

A variety of factors determine species diversity. These include: size and age of the woodland; size and age of individual trees; stand structure; diversity of habitats and micro-habitats; and the amount of deadwood. The species-richness of flowering plants and ferns increases with the size and age of the woodland (see Section B1: Area and Section B2: Ancient and Long-Established Woodland) and this correlation probably also applies to bryophytes, lichens and fauna. Large trees provide a greater range of micro-habitats than small trees, and deadwood is particularly important for saproxylic organisms – see Section B8: Dead and Decaying Wood. The richness of woodland species will be maximised by protecting and, where appropriate, creating a diversity of habitats and micro-habitats. Careful silvicultural management is critical in this regard, due to its influence on stand composition, light levels and micro-climate.

Grazing levels also have a major influence on species diversity within woodlands.

*White Prominent (*Leucodonta bicoloria*) settled on the underside of a birch leaf, Lickeen Woods, Co. Kerry. This rare species of moth is associated with native woodland. (Photo B. Nelson)*

Overgrazing can severely impact on certain species of vascular plants, reducing their abundance and preventing flowering and regeneration. Paradoxically, however, it can be beneficial for bryophytes. Undergrazing can result in the dominance of one or more plant species, which can then suppress more light-demanding species. But again, undergrazing does not always have negative impacts. For example, a dense growth of bramble arising from undergrazing is generally undesirable in terms of any necessary planting and / or natural regeneration. However, it may provide optimum conditions for certain species of bird, such as wood warbler (*Phylloscopus sibilatrix*), which would otherwise be precluded if grazing was too intense.

In general, invasive species, particularly non-native invasives, have a negative impact on both flora and fauna within native woodland stands. See Section B7: INVASIVE SPECIES for information on their control and removal.

Particular attention should be paid to rare and / or local species that may require special management measures to ensure that their habitat is not unduly disturbed. These include epiphytic lichens and bryophytes, which tend to be most abundant and diverse on old trees, including hazel, especially in the west of the country. The felling of individual epiphyte-rich trees will destroy their habitat. Similarly, the felling of surrounding trees may affect these species, by adversely changing the micro-climate. The removal of dead and decaying wood may destroy the entire habitat for saproxylic organisms – see Section B8: DEAD AND DECAYING WOOD.

Some tree species have a very localised range as a result of climatic and other factors. Perhaps the most widely recognised is the strawberry tree, which is largely restricted to southwest Kerry and southwest Cork. Several species of whitebeam also have a very localised distribution. Some herbaceous species, such as kidney saxifrage and Irish spurge, are largely restricted to the southwest corner of the country. Many bryophytes occur mostly in the western half of the country, where the climate is exceptionally mild and damp. No attempt should be made to artificially expand the range of these localised species, but conditions should be maintained to ensure their survival where they do occur. Some birds have a very restricted distribution which may be climatic, but which may also be related to woodland structure, e.g. wood warbler. Their range may be increased by appropriate management, where this is a critical limiting factor.

Management guidelines

- Ensure both structural diversity and habitat diversity in order to encourage a diversity of native woodland species.
- Encourage diversity of tree species where any current dominance is likely to be a product of previous management (e.g. abandoned coppice-with-standards oak woodland).
- Protect and encourage the development of micro-habitats for invertebrates, fungi, lichens, etc.
- Avoid excessive disturbance that often encourages ruderal and general woodland species at the expense of specialists. This type of species-richness is not desirable.
- Take account of rare or uncommon species and ensure that management practices protect their habitats, e.g. the application of shelterwood or selection

(Left) Stitchwort, a common species in oak woodland on more fertile soil.

(Right) Columbine, an uncommon species mostly on limestone soils. Derrycrag Nature Reserve, Co. Galway.

silvicultural systems to facilitate species requiring permanent shade, or the application of coppicing for species requiring open habitats.

- Ensure that individual trees of particular importance for epiphytes are not felled, and that any felling in the vicinity of such trees does not significantly change the micro-climate.
- Monitor and intervene, if necessary, to ensure that grazing does not negatively impact on species diversity. Reduce overgrazing, typically by culling and / or fencing. Severe undergrazing could be addressed by allowing grazing, preferably by horses or cattle, *but only on a strictly controlled basis and for limited periods of time*. Also see Section B6: GRAZING.
- Monitor and control invasive species to minimise their impact on native woodland species diversity. This may apply to certain native species (e.g. bracken, bramble) as well as non-natives. Also see Section B7: INVASIVE SPECIES.

Examples of good practice

Most Nature Reserves and National Parks are being managed to maintain and improve habitats, and therefore species diversity. The current management of the woodland ecosystem in these areas provides the necessary conditions for certain rare and protected species, e.g. bat species, Killarney fern.

5. Natural Regeneration

Objective: Ensure that the younger age classes of trees are present in adequate proportions to ensure the long term survival and rejuvenation of the woodland canopy.

Overview

Natural regeneration is the establishment of trees and shrubs from seed arriving naturally through a variety of means (e.g. animals, wind, water) from overhead, adjoining, nearby or remote seed sources. From an ecological perspective, where these new trees and shrubs are native, genetically diverse and representative of the native woodland type appropriate to the site, natural regeneration is far preferable to planting. Often, however, some level of intervention is required to facilitate the process.

Principal factors determining successful natural regeneration include the presence of a suitable and adequate seed supply, sufficient light levels and appropriate grazing pressure on the ground flora, to facilitate seed germination and subsequent survival. Under suitable conditions, natural regeneration of many of our native tree species can be prolific. While the majority will succumb to various factors, it only requires one individual to survive and grow to maturity in order to replace an existing tree.

Most of our native tree species, with the main exception of holly, are light-demanding at seedling stage. Consequently, their regeneration occurs primarily beneath gaps in the overhead canopy, in clearings, along ridelines, tracks and paths, under an open canopy or on adjacent open land. The amount of light reaching the woodland floor is a function of the canopy and shrub layers: holly, hazel and yew cast heavy shade, while ash and birch cast a light shade. The absence of regeneration may simply reflect

Natural regeneration of oak, Glengarriff, Co. Cork. Ecologically, natural regeneration is preferable to planting, although various factors may limit its application on particular sites.

unsuitable light levels or the immature age of the stand, and should not necessarily be a cause for concern. However, if light levels are good and regeneration is still absent, some other limiting factor may be responsible, such as over- or undergrazing, seed predation or indeed, suppression by invasive species such as rhododendron.

Of the principal canopy-forming trees, ash is by far the most prolific seed producer. However, while seedlings are often present in huge numbers (17,500 seedlings per 100 m^2, in the case of one instance described by Perrin *et al.* (2008)), very few develop to sapling stage. Ash can survive for many years in a near-moribund state under shade, only to then undergo rapid growth to form dense thickets, once the canopy is opened. Seedlings of birch and alder are seldom found under the canopy, but both will regenerate abundantly in suitable conditions within clearings. In contrast, oak regeneration may be abundant under the canopy, and due to their large seed reserves, individual seedlings can survive for several years in an unsuitable light climate. However, the majority will eventually die unless the canopy is opened up. Oak can regenerate readily in clearings, but dense growth of bramble, bracken and some other species can suppress seedlings. For these reasons, careful management of the overhead canopy is needed to provide just enough light; too small an opening and the oak seedlings will die off, while too large an opening may lead to a profusion of species such as bramble and bracken, which may suppress the seedlings.

On certain sites, several non-native tree species seed prolifically, particularly beech, sycamore and (locally) Lodgepole pine. Where mature trees of these species are present in the canopy or nearby, the creation of open spaces can encourage their regeneration to the detriment of native species. Non-native trees either approaching or of seed-bearing age should therefore be removed from the canopy, to reduce the potential for their regeneration and to create gaps for native trees and shrubs. However, be aware of the value of older non-native trees, particularly those of veteran status. Such specimens may form important habitats for bats or for saprophytic organisms, or may have a significant landscape, cultural or historical value. As such, reasons for retention may outweigh reasons for removal. If individual trees are retained, they should be

Naturally regenerating birchwood, Vale of Clara Nature Reserve, Co. Wicklow.

A veteran beech tree, Balrath Wood, Co. Meath. Such trees have great biodiversity value but any associated regeneration must be controlled.

allowed to grow on and to die naturally, while ensuring that the surrounding areas are monitored as part of ongoing woodland management, and that any natural regeneration that does occur is removed.

Where the natural regeneration of native species is insufficient or unpredictable, planting should be considered, either whole or in part, to supplement the process and to achieve adequate numbers and distribution within the relevant area. For further information, see Section B10: CONVERSION.

Management guidelines

- Assess the overall age class distribution of the trees (from seedlings upwards) and the extent of natural regeneration occurring within the woodland. Where both are adequate and the woodland is self-sustaining, intervention is not required. However, if the age class distribution is unbalanced (e.g. inadequate numbers of younger trees to supply natural recruitment within the canopy) and / or if natural regeneration is absent or inadequate, intervention is required.
- Determine any limiting factors preventing adequate natural regeneration: is it due to low light levels, inadequate seed sources, under- or overgrazing of the woodland floor, or the presence of non-natives or exotics such as beech or rhododendron, which are inhibiting the process?
- Where light is the limiting factor, consider whether the age of the stand is critical. This may be particularly relevant in abandoned oak woodlands, for example, where there is an even-aged canopy. If necessary, thin the canopy or create clearings, to increase light levels.
- While natural regeneration of native trees is generally welcome, exceptions exist. For example, newly developing hazel scrub over limestone pavement may swamp out other habitats of considerable value and may need to be controlled.
- If overgrazing is the limiting factor, take steps to control the animals. If this is caused by domestic stock, fencing access points will probably be sufficient. If deer or feral goats are the problem, culling and / or fencing will be necessary. Also incorporate features into the woodland to facilitate ongoing control, such

as ridelines, 'deer lawns' and elevated hides.

- Where adequate regeneration is present, formative shaping, respacing and thinning may be necessary if quality wood production is a management objective alongside woodland biodiversity. For information on appropriate silviculture methods, see Little & Cross (2005), Little *et al.* (2009) and DAFM (2015c) (the latter reference, regarding formative shaping). Also, seek advice from a professional forester.
- Where natural regeneration is not possible or is likely to be only partially successful, planting using appropriate native material (ideally locally-sourced) is an acceptable alternative. Note the legal requirements that apply under the Forest Reproductive Material Directive, aimed at guaranteeing the traceability of such material from seed collection to planting-out.
- Take cognisance of rare or local tree species, e.g. bird cherry, Irish whitebeam, and ensure that they have an opportunity to regenerate.
- Regeneration of non-native species (e.g. sycamore, beech) needs to be controlled. This is best done at the pole stage, when self-thinning may have reduced the numbers and individuals are easier to identify, and before vigorous seed production commences. For beech, an alternative may be to pluck out or cut young regenerating trees during the winter months, when retained leaves make them easier to spot. Consider how best to restock the resulting gap with native species, *via* natural regeneration and / or planting.
- Where bracken and bramble are inhibiting the emergence of young native trees (either naturally regenerating or planted), appropriate vegetation control may be required. On some sites, bramble may be protecting young trees from deer and should be retained, with any bramble shoots crossing over the young trees cut in order to ensure crown release.

Examples of good practice

- Glengarriff Nature Reserve, Co. Cork: Massive regeneration of native species occurred here following the clearfelling of conifers, and less prolific regeneration following the clearance of rhododendron. Grazing is not an issue on this site.
- Glenveagh National Park, Co. Donegal, and Killarney National Park, Co. Kerry: Good localised regeneration of native species following deer control using fencing and culling.

6. Grazing

Objective: Ensure that grazing levels are compatible with the maintenance of structural and species diversity, wood production (where appropriate) and the long term survival of the woodland.

Overview

Grazing by herbivores is an integral part of woodland ecology. Where it occurs at appropriate levels, it facilitates structural diversity, encourages high levels of biodiversity in the ground and field layers, maintains open areas and stimulates natural regeneration. Unfortunately, grazing pressure in Irish woodlands is rarely at 'appropriate' levels – typically, it is either too high or too low.

An appropriate level of grazing is, however, hard to define and probably site-specific. Where grazing pressure is too high, field and shrub layers are damaged, bark may be stripped from trees, regeneration is prevented or restricted to inaccessible corners, and both bird and invertebrate populations may decline. Selective feeding by grazing animals can reduce the abundance of specific species, e.g. oak seedlings, ling heather. It can also favour the establishment and spread of invasive species, including rhododendron. Where grazing is too low, the field layer may become dominated by a few aggressive species (e.g. wood rush) to the detriment of others, while structural open areas may be lost through colonisation with trees and shrubs, or become dominated by bramble or bracken.

Soil fertility directly influences the natural carrying capacity of a woodland, i.e. the number of grazing animals required for the long term survival and development of the woodland. Poor soils have a lower carrying capacity and are more susceptible to nutrient loss if the site is overgrazed. In contrast, fertile soils provide more palatable grazing

*Red deer (*Cervus elaphus*). Grazing is a natural driver for change in native woodland ecosystems. However, careful woodland design and management with the context of a wider landscape control strategy are required, to prevent unsustainable levels which impact severely on the woodland habitat. (Photo T. Burkitt)*

Vigorous regeneration within a small exclosure contrasts strongly with the overgrazed foreground. Tomies Wood, Killarney National Park, Co. Kerry.

and generally have a higher carrying capacity. Carrying capacity must be considered at a landscape level, as surrounding land types and land uses will have a direct bearing on the specific carrying capacity of the woodland. For example, a small native woodland on fertile soil surrounded by intensive pasture may have a higher natural carrying capacity than an extensive woodland surrounded by poor quality blanket bog. Ultimately, the carrying capacity from a management perspective is defined by the level of grazing impacts that the manager regards is tolerable. This may often be below the natural carrying capacity of the land.

The National Survey of Native Woodlands (Perrin *et al.*, 2008) concluded that overgrazing was confined to a relatively few localities, principally unenclosed upland areas where there were large numbers of deer or feral goats, such as the Wicklow Mountains, south Kerry and east Galway. However, in recent years, the populations of deer appear to have increased considerably in many parts of the country. Serious damage to woodlands is now being reported widely, to the extent that growing broadleaf species has become virtually impossible in places without extensive fencing and other forms of control. Undergrazing, however, was recorded by the NSNW in some enclosed lowland woods, with instances of overgrazing limited to a few sites used by domestic stock in the winter.

In contrast to deer grazing, sheep grazing, especially on the western seaboard, has declined in recent years with changes in EU agricultural policies.

Reducing overgrazing to an appropriate level can be difficult to achieve in woodlands, particularly where the principal grazers are deer or feral goats or where there is trespass and uncontrolled grazing by domestic stock. Fencing is currently the primary management tool used to control grazing. Typically, wire-and-post fencing erected around part or all of the woodland is used to exclude grazers. However, alternatives exist, including pocket exclosures, temporary and moveable 'A-frame' fencing, and dead-hedging using brash, including cut rhododendron. While these methods can be successful (particularly if the area being protected is small), they all require frequent maintenance to ensure that they remain stock-proof.

However, fencing should be considered as a short term solution or as a last resort, as the fundamental key to alleviating grazing issues in woodlands is proactive management, through culling. This will result in healthy, well-regulated deer populations that can live in harmony with sustainable woodland ecosystems. The culling of deer needs to be undertaken regularly on a professional basis in order to maintain numbers at an acceptable level. An understanding of resident population levels is required for effective culling, to ensure that the right number and class of animals are removed. This is best achieved through an agreed census method, such as Faecal Standing Crop Counts. Census work is best carried out by trained and experienced individuals. Great care must also be taken to minimise any dramatic disturbance to populations arising from culling, which may be counterproductive in the long term. Furthermore, measures to ensure public safety are paramount. The achievement of a sustainable deer population also requires wider countryside management strategies involving different stakeholders, and achieving this is a focus of the Irish Deer Management Forum (Anon., 2015).

Ideally, due to their intense grazing behaviour, feral goats should be totally removed or excluded from within and around native woodlands.

Infrastructural measures to facilitate deer and feral goat control should be incorporated into a native woodland, either at the initial planning stage (if developing a new native woodland on open land or following conifer clearfell) or gradually over time (if managing an existing woodland). Measures include well-placed ridelines and dedicated deer lawns, and the installation of elevated hides at strategic locations, overlooking good sight lines with suitable ballistic backstops. For further information, see the Woodlands of Ireland Information Note entitled *The management of deer in native woodlands* (Höna *et al.*, in prep.).

Regarding trespass by domestic stock, ongoing fence maintenance is of course required, and dialogue with neighbours may alleviate the problem. Legal action can be taken, but usually as a last resort.

There are arguments both for and against the various methods described above, and decisions should be taken on a case-by-case basis. A combination of two or more

(Left) Conventional deer fencing, Charleville, Co. Offaly.

(Right) Moveable A-frame deer fencing, Killarney National Park, Co. Kerry. (Photo E. Curran)

measures is often most effective.

Where undergrazing is a cause for concern, consideration should be given to introducing grazers on a carefully controlled and monitored basis for a short period of time. Cattle and ponies are good for controlling dense herbaceous vegetation, and their trampling can create sites for tree seedlings to establish (Mayle, 1999).

Grazing by domestic animals within woodlands may be a long-established tradition, creating a form of wood pasture which has its own characteristic ecology, e.g. some areas of old hazel woodland in the Burren. In such cases, this is an entirely acceptable practice if the grazing is extensive in nature and the pressure low enough to permit occasional regeneration. Cattle and horses are preferable to sheep or goats, which can cause serious damage. Persistent and heavy grazing pressure, especially by sheep, can reduce woodlands to stands of trees with a closely-cropped herb layer and a total absence of regeneration. If left unchecked, this will lead to the eventual collapse and disappearance of the woodland. It should be remembered, however, that woodlands are robust systems that can recover relatively quickly from heavy grazing pressure, provided the trees are allowed to regenerate from time-to-time. Regeneration by seed can occur in areas among piles of brash or fallen branches, where grazing animals are excluded. Meanwhile, some species, especially hazel, regenerate within a woodland principally by vegetative means. In cases of severe grazing, the exclusion of animals for a decade or more may be required to enable the ground flora to recover and the trees to regenerate.

In the case of both over- and undergrazing, baseline surveys are needed before management measures can be implemented, in order to assess the effectiveness of the methods used. Further research is needed to establish appropriate animal stocking levels and grazing regimes for different native woodland types within the Irish context.

Projects supported under the Native Woodland Scheme must be adequately protected from grazing by wild animals and domestic stock, by fencing or some other appropriate barrier. In the case of wild animals, fencing should be complemented by professional culling. Any approach involving periodic grazing must be agreed in advance with the Forest Service, and will only be considered *on a strictly controlled basis and for limited periods of time*.

In some parts of the country, deer populations may be so high that the development of new native woodland and the restoration of existing native woodland will pose considerable challenges.

Management guidelines

- Incorporate infrastructural measures to facilitate deer and feral goat control. See Höna *et al.* (in prep.) for details.
- Where grazing pressure is high, appropriate fencing should be erected, monitored and maintained to exclude the animals. Refer to the Forest Service *Forestry Standards Manual* (DAFM, 2015c) for appropriate fencing specifications for different grazing animals. Generally, small exclosures tend to be more effective, as animals are less likely to break in and the fences can be more easily maintained. Once the vegetation has recovered and there is sufficient regeneration of trees, the fences can be removed. This may take 15

Deer tree shelters can be used to establish tree cover on a smaller scale within areas susceptible to deer grazing, e.g. within woodland coupes or open spaces. Charleville, Co. Offaly.

years or more, depending on the site conditions. Deer tree shelters can also be useful to establish tree cover on a smaller scale, for example, within woodland coupes.

- If grazing pressure remains high, fences should be moved over time around the woodland, to promote a diversity of stand structure. Moveable A-frame fencing can provide this level of versatility, especially on steep and rocky terrain where standard wire-and-post fencing is expensive or impractical. Brash fencing ('dead-hedging') is a possible alternative if sufficient material is available (as may be the case on sites undergoing rhododendron clearance or conifer clearfell) and if properly constructed and maintained.
- Fencing alongside streams and rivers requires careful consideration. By corralling deer passage, fencing parallel to the streambank can lead to excessive poaching and silt runoff into the water. Such fencelines can also capture debris washed down during floods. Existing drains can provide entry points beneath fencelines, and this needs to be considered during installation.
- If fencing is required, it implies that population levels are too high and the numbers of grazers need to be controlled. In the case of deer or feral goats, ongoing professional culling will be required to reduce populations to tolerable levels.
- Where numbers are relatively low, the culling of deer is a better option than fencing. The objective should be to prevent numbers increasing to an unacceptable level.
- If domestic livestock is the issue, then discussions with the owners of the animals involved will be necessary. Appropriate legal measures will be required where such discussions prove unsuccessful.
- Where grazing pressure is too low, consideration should be given to introducing animals – ideally cattle or ponies – *but only on a strictly controlled basis and for limited periods of time*. Grazing for a few weeks every year may be sufficient to

reduce the suppression of natural regeneration by a dense field layer. Sheep and pigs are generally unsuitable.

- Grazing by domestic livestock in wood pasture is acceptable at low densities and should be allowed to continue. The appropriate number of animals and grazing duration are both site-specific.
- If undertaking coppicing, grazing should be initially excluded or controlled to allow the new shoots to develop from the stools. Temporary fencing or the piling of coppiced branches over the stools may be a useful option.
- When planning and erecting fences, minimise site and habitat impacts (e.g. soil disturbance) as far as practical.
- Baseline surveys should always be undertaken before any measures to control or to introduce grazing are implemented, so that the impacts can be fully assessed.
- Projects supported by the Forest Service must be adequately protected from grazing by wild animals and domestic stock, typically by fencing. Any approach involving periodic grazing must be agreed in advance with the Forest Service, and will only be considered on a strictly controlled basis.

Examples of good practice

Deer and goat control measures have been introduced in various places but with mixed results. In the Killarney and Glenveagh National Parks in Kerry and Donegal, a combination of culling and fencing has had good results locally in encouraging the regeneration of trees and the herb and shrub layers.

7. Invasive Species

Objective: Control invasive species and to reduce the area that they occupy.

Overview

The principal problems with invasive plants normally arise with non-native species. However, some native species which produce dense cover, such as bracken and bramble, may also pose problems, particularly for the natural regeneration of native trees and shrubs. As a general policy, non-native species should form no more than 10% of the shrub and canopy layers within a native woodland.

The National Survey of Native Woodlands found that the most abundant non-native trees posing a potential threat to native woodlands were sycamore (which occurred in 73% of the stands surveyed), beech (69%) and Sitka spruce (25%). The most abundant non-native shrubs also posing a potential threat were rhododendron (23%), cherry laurel (20%) and snowberry (12%). These figures underestimate the area of woodland impacted by invasive species, as sites with very dense growth were excluded from the survey. Other species that are locally invasive and potentially problematic include: red-osier dogwood, Japanese knotweed and Himalayan balsam, all three mainly in alluvial woodlands and each posing a threat to water quality. Other potentially problematic species include eucalyptus species, orange-barked myrtle, Himalayan honeysuckle, Himalayan knotweed, shallon, montbretia and certain conifers, e.g. Western hemlock.

Non-native species can be divided into three categories, as follows:

- **Non-invasive species** include lime, sweet chestnut and certain conifers such as larch and Norway spruce, which were often planted during the 18th and 19th centuries. In general, these species do not regenerate or do so only slightly, and normally do not pose a threat to native woodlands. Some may actually be

Cherry laurel and beech on an ancient woodland site, Charleville, Co. Offaly.

of conservation value, particularly if they provide deadwood, contain rot holes or act as nesting / perching sites for certain bird species. Similarly, the open deciduous canopy of larch facilitates a rich diversity of vegetation beneath. These trees can be left *in situ* and targeted for gradual removal over the long term.

- **Slight to moderately invasive species** include species such as cherry laurel, snowberry and red-osier dogwood, which spread principally by vegetative means (although regeneration of cherry laurel by seed appears to be increasing in recent years). Cherry laurel is most abundant on base-rich soils, and red-osier dogwood on wet soils and along watercourses. While these species do not tend to spread far from their centre of origin, they nonetheless often form dense stands which cause considerable ecological damage.
- **Highly invasive species** include trees such as beech, sycamore and certain conifers, e g. Western hemlock, Sitka spruce and Lodgepole pine (the latter two species particularly on sites undergoing conversion from conifer forest to native woodland *via* clearfell and reforestation). Both beech and sycamore cast heavy shade and can suppress the herb layer and prevent the regeneration of native trees and shrubs. They can be very invasive on certain sites, although they may be relatively benign elsewhere. Where necessary, both species should be controlled and in general, the so-called 'mother trees' removed. However, an exception can be made for older specimens, particularly those of veteran status, primarily due to the habitat they provide for invertebrates, birds and fungi. These should be left *in situ* until they die naturally, but associated regeneration must be controlled – see Section B5 NATURAL REGENERATION.

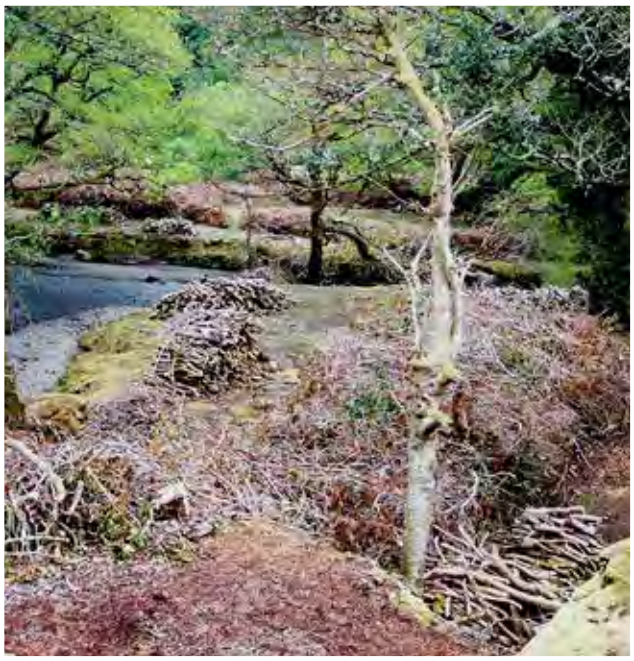
  Rhododendron ponticum is the most aggressive of all non-native plants found in our native woodlands, and its control presents immense difficulties. It is very widely distributed, principally (but not exclusively) on acidic soils. Details of its ecology and life history are well-documented (Cross, 1975, 1982 & 2002). Methodologies for its control are set out by Higgins (2008) and by Barron (2007),

Sycamore, a non-native species which can be invasive on more fertile soils.

Rhododendron ponticum *is a major threat to native woodland on many sites, but can be effectively controlled where a long term commitment is in place.*

(Left) Isolated rhododendron bush with flowers, Uragh Wood, Co. Kerry.

(Right) Cut and windrowed rhododendron, Killarney National Park.



the latter within the Woodlands of Ireland Information Note 3 (*The control of rhododendron in native woodlands*).

Management guidelines

- Assess the threat to the woodland ecosystem posed by invasive species, both native and non-native.
- Invasive native species may need to be controlled if they are preventing regeneration. Various mechanical and / or chemical means can be used. Within designated sites and other environmentally-sensitive areas, chemical control should be used as a last resort.
- Concentrate action on those species posing the most serious threat to the woodland.
- Emphasis should be placed on monitoring and prevention, rather than cure, with the focus on the early removal of invasive species before they become well-established. Where adjacent land is the source of infestation, management should aim to reduce the chances of spread. Where possible, the adjoining landowner should be approached to discuss the removal of the threat.
- Where present in significant numbers, remove invasive non-native trees such as beech and sycamore over several years, to avoid sudden changes in moisture, shade and other woodland habitat conditions. The focus should be on the gradual opening up of the canopy to facilitate native species, and the removal of non-native regeneration. Old or veteran trees can be left for their ecological, landscape or cultural value, but associated regeneration must be controlled.
- For certain tree species that regenerate thickly (e.g. Western hemlock), it may be more appropriate to allow the trees to reach pole stage. At this stage, a degree of self-thinning will have taken place, and the trees will be easier to fell and remove, and may be of some commercial value.

- Ring-barking or stem injection with herbicide may be suitable for removing individual or small groups of invasive species within the canopy, particularly on sites highly sensitive to disturbance. However, this approach creates deadwood high up in the canopy, with health and safety implications – see Section B8 DEAD AND DECAYING WOOD.
- Aim to achieve and maintain a canopy of 90% or more of native species.
- In relation to particular species, seek advice from practitioners who have tackled these on similar sites elsewhere, and / or consult published and online resources (e.g. www.invasivespeciesireland.com).
- Be ever-vigilant for newly introduced plants that may prove to be invasive in the medium to long term.
- The basic principles of rhododendron control are as follows:
    - Devise and implement a rhododendron control plan, drawing from the experience and guidance derived from similar initiatives elsewhere (e.g. Barron, 2007).
    - Prevent it from gaining a foothold in areas where it is currently absent. Contain its spread in areas where it is already present, ideally working from areas of slight infestation to areas of dense infestation.
    - The direction of work should be with the prevailing wind, so that areas that have been cleared are upwind of the seed source, thereby minimising the risk of reseeding and re-infestation.
    - Cut and treat stumps with herbicide. Alternatively, if stem diameter is large enough, kill individual plants standing by notching and treating stems with herbicide.
    - Monitor treated and adjoining areas, removing on a regular basis any new seedlings that appear.
    - Prevent re-establishment by encouraging the rapid development of a dense native ground cover and by keeping grazing and soil disturbance to a minimum.
    - Remember that rhododendron management is an ongoing, long term measure, and that monitoring, prevention and containment are key requirements.

Examples of good practice

- Nature reserves at Deputy's Pass, Co. Wicklow, and Ballykeefe and Kyledohir, Co. Kilkenny: The removal of invasive conifers and beech as part of native woodland restoration works has greatly improved the condition of these woods.
- Glengarriff (Co. Cork), Killarney National Park (Co. Kerry), Glenveagh National Park (Co. Donegal) and Union Wood (Co. Sligo): Extensive clearance of rhododendron and ongoing control of regrowth.
- Ballykilcavan, Co. Laois: Cherry laurel control undertaken as part of woodland management.

8. Dead and Decaying Wood

Objective: Retain or create a diversity of dead and decaying wood, both standing and fallen.

Overview

Deadwood is an integral and essential component of any woodland as, in the process of decay, new habitats are created for a great variety of organisms, particularly invertebrates and fungi, and nutrients are recycled. In many of Ireland's native woodlands, it is generally regarded that deadwood – particularly larger diameter material ('coarse woody debris') – currently occurs in quantities far less than those that would naturally occur in the absence of human intervention (i.e. removal).

There are many different types and qualities of deadwood, each providing different niches supporting its own suite of associated organisms. Deadwood goes through a decay process from fresh to fully-decomposed, and each stage provides different conditions and habitats for different organisms. Deadwood can be present through natural woodland processes and / or as a result of management, e.g. pruning, thinning, fell-to-waste.

The most commonly recognised types of deadwood are:

- fine woody debris
- coarse woody debris
- standing deadwood (see below)
- uprooted root plates (which may not always be entirely dead)
- snags / snapped trees
- deadwood in watercourses.

Decaying stumps form one component of the overall deadwood resource within native woodlands.

Standing deadwood includes:

- dead limbs on living trees (e.g. as found on so-called 'stag-headed' trees)
- rot holes
- dead bark
- decay columns in trunks and main branches
- sap runs from decaying cavities or recent wounds.

Veteran trees may contain all of the above types of standing deadwood and are particularly valuable for invertebrates, birds, bats and fungi, as well as for epiphytes requiring a continuity of micro-habitats.

The amount of deadwood within Irish woodlands is poorly documented. The National Survey of Native Woodlands (Perrin *et al.*, 2008) found that fine woody debris (i.e. material <5 cm in diameter) and coarse woody debris (≥5 cm diameter) were occasional to frequent in the majority of sites, and that standing deadwood was relatively uncommon. However, there are no quantitative data provided by this survey. Sweeney *et al.* (2010) found that the mean volume of dead logs in a small sample of young Irish oak and ash woodlands was *c.*20.5 m^3 / ha and 27 m^3 / ha, respectively. Ninety percent of the logs were <20 cm in diameter. Mean snag density was 92 stems / ha in oak woods and 87 stems /ha in ash woods, most being <20 cm in diameter. Most logs and snags were partially rotted.

These values are not dissimilar to those for Britain but are relatively high compared to values found elsewhere in Europe (e.g. Barbati *et al.*, 2013). However, they are low compared to old growth stands in Europe, where up to 160 m^3 / ha of deadwood have been recorded (Gilg, 2005).

The recommended amounts of deadwood within a native woodland vary considerably and are sometimes conflicting. It is generally accepted, however, that large diameter deadwood provides a far wider range of habitats than smaller diameter deadwood. As

A veteran oak tree, possibly over 400 years old, with dead boughs and bracket fungi. Charleville, Co. Offaly.

(Left) Highly decomposed birch wood.

(Right) Bulgaria inquinans *on fallen deadwood, Tomies Wood, Killarney National Park.*

the calculation of deadwood volume within a woodland ecosystem is difficult, a more pragmatic approach is to aim to realise the different types of dead and decaying wood, as listed above. This will ensure a variety of habitats for the widest suite of organisms possible. Such a policy has been adopted in Baden-Württemberg, Germany, whereby groups of 15 trees for each 3 hectare area are left to mature, die and decay naturally. Furthermore, single habitat trees with crucial structures (e.g. large woodpecker holes) are marked and protected, and small forest stands of high conservation value are set aside completely so that they can develop and decay naturally (Spielmann *et al.*, 2013).

Management guidelines

- Ensure the presence of a variety of dead and decaying wood, including large diameter material. As a general guide, leave five trees *in situ* within each hectare of woodland, either as single trees scattered throughout or in the form of a small group(s). These should be allowed to grow on indefinitely to form ancient specimens and to provide necessary standing deadwood.
- Aim to achieve large deadwood on the woodland floor, in the form of trunks and branches. If felling trees for compatible wood production, leave approximately 10% of the woody material *in situ*, including large branches and sections of log.
- Where absent, large diameter deadwood should be created, where possible. If the woodland contains relatively young trees, it will take time for large diameter deadwood to develop. See Cavalli & Mason (2003) for details on techniques.
- Standing deadwood can be created by ring-barking. See Section B7: Invasive Species for details.
- Many windthrown trees remain alive and should not be removed, as the subsequent growth from branches can greatly diversify the woodland structure.

- Mature or veteran trees should be left *in situ*. This also applies to non-natives, although natural regeneration must be controlled – see Section B5 NATURAL REGENERATION).
- The creation of minimal intervention areas will facilitate the development of deadwood and its cycle of decay.
- Piles of deadwood may be created on the forest floor, but should be appropriately located (e.g. away from woodland car parks) to avoid theft for firewood and to prevent a danger to public safety.
- The above measures involving the creation and retention of standing and overhead deadwood can create a serious safety hazard, particularly in relation to foresters, ecologists and operators who may be working within the vicinity. If used, these methods should be limited to remoter areas of the woodland, and well away from paths, roads and other areas frequented by the public. The location of the trees involved should also be captured using GPS and mapped, and clearly highlighted in the management plan, to inform future parties. Similarly, while still-living windthrow trees should be retained where possible, safety concerns may rule out this option.
- Generally, deadwood does not pose a health risk to living trees. However, situations can arise where it is necessary to remove dead trees killed by an aggressive pathogen, to control potential spread.

Examples of good practice

- Tomies Wood, Killarney National Park, Co. Kerry: Windthrown trees left *in situ*.
- Vale of Clara Nature Reserve, Co. Wicklow: Windthrown stems, purposefully-felled trees and standing deadwood left *in situ*.

9. Afforestation

Objectives:

- ***increase the area under native woodland, through the creation of new native woodland on open sites; and***
- ***ensure that such afforestation is realised with minimal site disturbance and inputs, comprises species reflecting the most appropriate native woodland type for the site, and is designed to best achieve objectives regarding woodland biodiversity, the delivery of other ecosystem services, and compatible production.***

Overview

The expansion of Ireland's native woodland resource can be realised through: (i) the afforestation of appropriate greenfield sites with new native woodland; and (ii) the conversion of non-native forest to native woodland.

When applied to sites beside or close to existing native woodland, both approaches represent an expansion of that woodland and its ecosystem (including the extent of the valuable interior habitat) and provide additional habitat for a range of organisms. When applied strategically at a wider landscape level (e.g. within the context of a National Park or a water-sensitive catchment), expansion through afforestation or conversion can be used to increase and enhance the existing native woodland resource, to improve connectivity between semi-natural habitats, and to enable the targeted 'delivery' of other ecosystem services, such as the protection of water quality and aquatic habitats and species (e.g. freshwater pearl mussel). In this regard, GIS-based planning tools can be very effective in identifying the most significant sites to focus effort.

Ireland's countryside contains many opportunities for afforestation with native woodland. These new woodlands form semi-natural habitats, expand native woodland cover nationally and deliver important ecosystem services such as habitat linkage, water protection and wood production. New native woodland (mid-ground) at Garryknock, Co. Wicklow.

A KerryLIFE site visit to recently planted native woodland at the Gap of Dunloe, Co. Kerry, to discuss this landuse option with farmers and other landowners from the nearby Caragh and Kerry Blackwater catchments. Forestry trials under the KerryLIFE project include native woodland creation, to protect the highly-endangered freshwater pearl mussel.

Native woodland expansion, either through afforestation or conversion, also provides the opportunity to build in provisions for future wood production compatible with primary ecological objectives.

This section addresses the practicalities associated with the afforestation of open greenfield sites with new native woodland. Section B10 Conversion addresses the conversion of existing non-native forest to native woodland.

Key considerations

Key considerations apply when afforesting open sites with new native woodland, including the following:

- Assess the site and note the soil type, drainage, elevation, ground vegetation, and adjoining and nearby hedgerows and semi-natural woodlands (if any). These factors will all point towards the most appropriate native woodland type for the site (or different parts of the site), which will then inform which species of trees and shrubs to plant.
- Adopt a robust planting design that involves key species and avoids the likely suppression of any individual component as the woodland emerges. Do not focus too greatly on minor species associated with the woodland type identified for the site, as these are likely to colonise the site naturally over time.
- Scenarios set out under the Native Woodland Establishment Scheme are relevant to all projects, whether grant-aided or not. These provide a framework for identifying the most appropriate native woodland type for a site, and the corresponding planting mixture to implement – see Table 1 (from DAFM, 2015b).
- Ensure that all material used (seeds, plants, cuttings) originates from suitable sources within Ireland, and is compliant with the Forest Reproductive Material

Table 1 *Scenarios 1-4 set out under the Native Woodland Establishment Scheme (based predominantly on soil type), the corresponding native woodland type (see Appendix 2), and the planting mixture formulated as a 'start-up kit' for that woodland type. From* Native Woodland Establishment GPC9 & GPC10: Silvicultural Standards (September 2015) *(DAFM, 2015b).*

NWS Establishment Scenario	**Most appropriate native woodland type**	**Corresponding planting mixture**
Scenario 1: Podzols / Oak – Birch – Holly Woodland	QL Sessile oak – woodrush	➢ Sessile oak (30%) & Scots pine (30%), with downy birch (15%), rowan (15%) & holly (10%). ➢ Sessile oak planted in predominantly pure groups, with downy birch (3%), holly (2%) & rowan (2%) scattered intimately throughout oak. ➢ Scots pine planted in small pure groups, focusing on parts of the plot with free-draining soil (if present) & away from any watercourses adjoining or crossing the plot. ➢ Remaining rowan (13%), downy birch (12%) & holly (8%) planted as an intimate mixture in remaining areas of the plot.
Scenario 2: Brown podzolics / Oak – Birch – Holly with Hazel Woodland	QL3 Bramble – hazel (subtype of QL Sessile oak – woodrush)	➢ Sessile oak (50%), with hazel (15%) & downy birch (10%) scattered intimately throughout, & with wild cherry (5%) planted in groups of 5 to 10 trees. ➢ Scots pine (10%) planted in small pure groups on free-draining areas of the plot, particularly on slopes. ➢ Minor species (10%) to comprise *at least two of the following*, positioned alongside planned woodland edges & glades: hawthorn, holly, rowan, crab apple.
Scenario 3: Brown earths / Oak – Ash – Hazel Woodland	FH Ash – ivy	➢ Pedunculate oak (40%), with downy birch (20%), hazel (20%) & hawthorn (5%) scattered throughout. ➢ Wild cherry (5%), planted in groups of 5 to 10 trees. ➢ Minor species (10%) to comprise *at least three of the following*, positioned alongside planned woodland edges & glades: holly, spindle, rowan, crab apple & (on wetter areas of the plot) alder.
Scenario 4: Gleys / Alder – Oak – Ash Woodland	AF Alder – meadowsweet	➢ Pure groups (30-40 trees) of alder (50%), grey willow (10%) & downy birch (10%). Groups interspersed alternately (to improve stability & robustness, & to prevent the development of an alder monoculture). ➢ Pedunculate oak (10%) on drier areas. ➢ Hawthorn (5%) scattered throughout. ➢ Minor species (15%) to comprise *at least two of the following*, positioned between the above pure groups: holly, hazel, guelder rose.
Although not included under DAFM (2015b), a fifth scenario may also be appropriate, for **highly modified peat and peaty podzols**. Such sites include: ➢ modified infertile upland acid brown earths and peaty podzols (often gleyed); and ➢ drained / improved peats / peaty gleys (moderately acid) on both upland (blanket bog) and lowland (raised bog) habitat. On such sites, the BM Birch – purple moor-grass woodland type may be appropriate, with the corresponding planting mix comprising downy birch, Scots pine, rowan and sessile oak (or a mixture of downy birch, grey willow and appropriate minor species on wetter sites).		

Directive regarding traceability from seed collection through to the planting site. This is critical in the native woodland context, where the source of the material used is a key consideration. The corresponding requirements that apply under the Native Woodland Scheme support package (DAFM, 2015a & 2015b) are relevant to all projects, whether grant-aided or not. If planting within a designated woodland, a greater emphasis on specific sources may be required for certain species.

- Retain semi-natural features and habitats such as hedgerows, small wetlands and rocky outcrops. Incorporate these in a way that allows their continued existence as discrete habitats in the future woodland. For example, use appropriate unplanted setbacks, in terms of both width and orientation to sunlight.
- Incorporate open spaces into the afforestation design, focusing on water setbacks, existing habitats and management features (e.g. ridelines for future access tracks and sight lines for future deer control).
- Any planned tracks and ridelines should be wide enough to remain open as adjacent trees increase in height. Also consider the orientation of these features, as this will influence sunlight and micro-climatic factors, and subsequent habitat development.
- Retained habitats and other open spaces will provide habitat structure and diversity within the future woodland, which will enhance its biodiversity value significantly – see Section B3: Structure.
- If needed, ensure that site cultivation, vegetation management and fertiliser application are tailored to site conditions, to maximise establishment success while minimising disturbance and inputs. On particularly sensitive sites or parts of sites (e.g. near sensitive watercourses), consider possible alternatives such as the use of planting augers, mulch mats and vermicompost.
- Higher planting densities will promote better establishment and will encourage the more rapid development of native woodland canopy on the site.

A young stand comprising ash and oak, established under the Native Woodland Establishment Scheme with minimal site disturbance and input. Manch Estate, Dunmanway, Co. Cork.

- Where appropriate, various measures applied from the outset create the basis for future wood production. These include specific planting patterns, higher planting densities and the application of shaping during the initial years, to promote good stem formation.
- Encourage the natural regeneration of native species, and control any unwanted regeneration, e.g. from sycamore in an adjoining hedgerow. See Section B5 NATURAL REGENERATION.
- Design open spaces within the woodland to facilitate deer management. Install and maintain appropriate fencing and other protective measures to protect trees from grazing animals. See Section B6 GRAZING.
- On greenfield sites, competition from a dense sward of vegetation can preclude natural regeneration and consequently, planting is often the only practical option for woodland establishment. However, on some disturbed sites and especially on abandoned cutaway bog, dense regeneration may occur, principally of birch. In such situations, additional planting may not be required, but re-spacing may be needed if timber production is a co-objective.
- Further information on establishment, design and stocking densities can be found in the Woodlands of Ireland Information Note 5 (*Establishment, design and stocking densities of new native woodlands*) (Little *et al.*, 2009). Collins *et al.* (2010) also set out useful guidance for woodland establishment and early management.
- Note that the creation of new native woodland on greenfield sites represents afforestation and therefore requires a licence under the Forestry Act 2014, as set out in the Forestry Regulations 2017 (S.I.191 of 2017) – see www.agriculture.gov.ie/forestservice for details.

Management guidelines

- Identify opportunities for strategic afforestation with native woodland, both at an individual site level (e.g. adjacent to existing woodland) and at the wider landscape level. This will focus effort on where the greatest benefit can be realised in terms of native woodland biodiversity, wider habitat linkage and the delivery of other ecosystem services, such as water protection.
- Identify the most appropriate native woodland type for each site, based on factors such as soil, elevation and existing semi-natural woody habitats in the surrounding area. Subsequently, use this to determine which species of trees and shrubs to encourage on the site, *via* planting and / or natural regeneration.
- Each site should be capable of supporting the sustainable long-term development of the most appropriate native woodland type identified for it. Otherwise, trees will struggle to establish and will require greater levels of filling-in, vegetation management and other inputs. Overall, the young woodland will remain vulnerable to grazing pressure and other threats for a longer period of time, and will face a greater risk of failure.
- Natural regeneration is the preferred method for afforesting new sites. However, the degree of success will depend on the presence of suitable seed

sources and management timelines.

- If planting, ensure that all forest reproductive material used is ecologically appropriate for the site and complies with regulatory requirements regarding traceability.
- The control of competing vegetation and protection against grazing will be critical factors in achieving early woodland development on greenfield sites.
- In some parts of the country, high deer populations may pose extreme challenges to afforestation with native woodland, and appropriate steps will be needed to ensure successful establishment and future development.
- Proven seed sources, planting designs, stocking levels and shaping can all create the foundation for future quality, where compatible wood production is a co-objective.
- Incorporate appropriate unplanted setbacks into the initial afforestation design, in order to protect non-woodland habitats, watercourses, archaeological sites and other sensitive features, as per the *Environmental Requirements for Afforestation*. Include other unplanted areas, as needed, to facilitate future management, e.g. access, deer control. The careful design and management of these open spaces – from orientation regarding sunlight to edge treatment – will contribute to the overall biodiversity of the emerging woodland.

Examples of good practice

- Delphi, Co. Mayo: Native woodland afforestation adjoining riverbanks within the Bundorragha freshwater pearl mussel catchment, with the primary focus on protecting water quality and the aquatic ecosystem, and local fisheries.
- Ballyvary, Co. Mayo: Native woodland afforestation on a riparian site, as part of a multi-purpose project involving the restoration of coppice woodland.
- Ballycoyle, Co. Wicklow: Expansion of existing sessile oak woodland through afforestation in contiguous areas, within the Glencree Valley. Deer fencing represents a central component of this project.
- Manch, Co. Cork: Afforestation trialling different planting techniques and species mixtures for riparian zone management, alongside woodland restoration works.

10. Conversion

Objectives:

- ***increase the area under native woodland, through the conversion of non-native forest to native woodland; and***
- ***ensure that such conversion is realised with minimal site disturbance and inputs, results in native woodland that comprises species reflecting the most appropriate native woodland type for the site, and is designed to best achieve objectives regarding woodland biodiversity, the delivery of ecosystem services and compatible production.***

Overview

As set out in Section B9 Afforestation, the expansion of Ireland's native woodland resource can be realised through: (i) the afforestation of appropriate greenfield sites with new native woodland; and (ii) the conversion of non-native forest to native woodland. Section B9 also details application of both approaches at a site level and at a strategic landscape level.

This section addresses the practicalities associated with the conversion of existing non-native forest to native woodland.

Non-native woodlands can range from mixed 'estate' woodlands of beech and larch, to more recent conifer plantations of Sitka spruce. Many of these are situated on sites of former native woodland. Some of these may be ancient or long-established woodland sites and may still retain important elements of those native woodland ecosystems, e.g. in the ground flora or invertebrate communities. As described below, conversion can

Dense regeneration of birch, Scots pine, oak and alder following conifer clearfell, Glengarriff Nature Reserve, Co. Cork.

be brought about through gradual transformation (using continuous cover forestry) or through replacement (by clearfell and reforestation). The optimal approach on any particular site will depend on a range of factors, including the composition and age of the existing canopy, the presence or otherwise of native trees that can act as a seed source, and site factors including accessibility and windthrow risk.

Transformation

Within the native woodland context, transformation can be described as the gradual conversion (over a number of years or decades) of a non-native and predominantly even-aged forest to uneven-aged native woodland, through the use of CCF. Generally, non-native broadleaved woodland, mixed woodland and early thinning stage conifer plantations lend themselves more readily to transformation, compared to mature stands of conifers.

CCF is a close-to-nature silvicultural approach highly suited to native woodland management. It enables gradual change through the emulation of natural woodland processes such as tree death or windthrow, entails minimal site disturbance, and maintains the woodland habitat and micro-climatic conditions as far as possible, thereby benefiting woodland species that may have persisted within or colonised the forest. For this reason, transformation should be selected over replacement in the case of non-native forests situated on ancient or long-established woodland sites, as these may still retain important elements of the native woodland ecosystem, particularly within the ground flora and invertebrate communities.

CCF also provides for the realisation (where appropriate) of quality wood products in balance with conservation and environmental objectives, spreading associated operations throughout the area over time and avoiding major disturbances such as clearfelling (see Section B11 PRODUCTS).

Three CCF systems are relevant to native woodland management – selection, shelterwood and coppicing (see Section B11 PRODUCTS for details). Selection and shelterwood are particularly relevant to transformation. Both involve the gradual opening up of the existing canopy through single tree or group felling, to facilitate the emergence of young native trees beneath, originating from planting and / or natural regeneration (if a suitable seed source is present). This process is repeated on a phased basis over a number of years, with the native trees eventually merging together to form a native canopy.

Overseeing transformation over decades requires an in-depth knowledge of the woodland itself and of the key silvicultural principles underpinning CCF, and the input of suitable forestry expertise is critical. Considerations such as woodland type and species mix, site conditions, and the degree to which individual species are light demanding or shade tolerant, will to a large extent determine which approach to adopt. The management of light levels is crucial – if too many trees are removed too quickly, the increased light levels may result in dense and aggressive ground cover (e.g. woodrush, bramble) that will inhibit the regeneration of native trees and shrubs and prevent recolonisation by slower colonising herb layer species. Conversely, if too few trees are removed, the low levels of light will prevent trees from establishing and developing within the gaps.

CCF also requires a good network of access tracks throughout the woodland, to facilitate

Phased transformation of a stable Sitka spruce plantation, through group selection. Brockagh, Glenmacnass, Co. Wicklow. (Photo P. Purser)

ongoing management and the periodic extraction of material from trees harvested individually or in small groups. The machinery used is often small in scale, although larger machinery can be more appropriate in various situations – see below.

Stands of Scots pine are often well-suited to transformation. Although re-introduced following its demise in the first millennium AD (Roche *et al.*, 2009), Scots pine may be treated as a native species in certain locations (i.e. on poorer acidic soils). Locally, it may be an important constituent of our woodlands, e.g. in regenerating birch woodland on cutaway bog. Scots pine plantations are typically open in nature and often contain native broadleaf species mixed within the canopy or as an understorey. Similarly, the field and ground layers are frequently well-developed and characteristic of native woodland. Such stands can be treated as native woodland and through careful long-term management can be transformed into a more natural and diverse woodland. Larch stands are similarly open and also often contain native broadleaf species. While not native, they can be treated similarly to Scots pine, although the long term objective should be to replace larch entirely with native species.

For further information on CCF, see ProSilva Ireland's website (www.prosilvaireland.wordpress.com). The Coed Cymru organisation, a partnership initiative to use, protect and enhance native woodlands in Wales, also demonstrates the use of CCF to generate wood products and income in balance with conservation (see www.coed.cymru).

Replacement

In certain situations, the gradual conversion to native woodland by transformation may not be realistic due to site and stand conditions. For example, any attempt to transform an older even-aged conifer stand on peat is likely to lead to catasphtopic windthrow early on in the process. (For example, see Purser *et al.* (2011).) In such cases, replacement may be the only viable option. Replacement is the abrupt conversion of a non-native forest to native woodland, through clearfelling and subsequent reforestation (*via* replanting and / or natural regeneration) with appropriate native species.

Replacement involving the clearfelling of a conifer stand and reforestation with native woodland by planting and natural regeneration. Note the need for deer fencing on this site. Coillte's Crone Forest, Co. Wicklow.

A former conifer clearfell site, reforested with planted oak, and naturally regenerating birch and willow. Co. Wicklow. (Photo P. Purser)

The following apply in situations where replacement is being carried out.

- Limit the scale of clearfell coupes as far as possible (although this is normally dictated by existing wind-firm edges) and carefully plan the operation to minimise site impact. For example, ensure full use of brash mats for machine traffic, to avoid soil compaction and damage – see UK Forest Research's *Brash management on habitat restoration sites* (2003) for guidance.
- Retain any native trees already present within the canopy being cleared. However, such trees can often be tall and spindly, and therefore very unstable once released. It may be preferable to stump-back or pollard such trees, to avoid windthrow. This will enable these trees to survive and grow on and ultimately, to act as a seed source for natural regeneration onsite, thereby

contributing to the development of an emerging woodland with a more diverse structure. This measure is also important alongside streams and rivers, to avoid windthrow and sediment release into the water from upturned roots.

- Reforesting clearfelled sites with new native woodland is similar in some respects to the creation of new woodland on a greenfield site (e.g. protection against grazing) (see Section B9 AFFORESTATION). However, important distinctions exist. For example, drain damming and the reinstatement of natural drainage conditions and small-scale wetland habitats may form part of the objectives of the project, with appropriate open spaces incorporated into the reforestation design. Also, brash and 'lop-and-top' left *in situ* from the clearfelling operation is normally gathered (or 'windrowed') into linear or spot piles to enable access for planting. Some sites may benefit from a light scarification, to facilitate natural regeneration.
- On clearfell sites, it is important to encourage the rapid establishment of the new replacement canopy. This will reinstate woodland conditions as soon as possible, thereby helping the survival of any woodland species that may have persisted under the former non-native canopy, before open conditions and associated vegetation eliminate them from the site.

Common considerations

The following are considerations that apply to both approaches to conversion, i.e. transformation *and* replacement:

- Carefully select harvesting and extraction machinery to minimise site impact. This could vary from manual chainsaw felling and extraction using 'iron horses' in localised areas of high sensitivity, to more conventional commercial harvesting and forwarding machinery. Avoid assuming that smaller machinery is always the better option – larger machinery may cause far less disturbance and disruption than smaller machinery, if the latter is struggling to deal with tree size and site conditions.
- Ring-barking may be appropriate to eliminate single or small groups of non-native trees, as discussed in Section B7: INVASIVE SPECIES.
- Fell-to-waste can be pursued in highly sensitive areas, whereby trees are felled and left *in situ* to decay over time. However, consider the possibility that the felled material may impede access for reforestation.
- Both transformation and replacement create the potential for realising wood. This is explored further in Section B11 PRODUCTS.
- Under both approaches, the use of natural regeneration to achieve the new native woodland canopy is ecologically preferable to the use of forest reproductive material (typically transplant stock) introduced onto the site. However, as described in Section B5 NATURAL REGENERATION, the potential for regeneration may be limited by a lack of suitable seed sources or infrequent mast years, and planting may be a necessity.
- Planting can be used in combination with natural regeneration. This can be useful over larger areas to supplement the natural colonisation process.

It can also be used to guarantee the presence of certain species that are associated with the 'target' native woodland type but poorly represented in the surrounding seed bank. Typically, supplementary planting of this kind takes the form of robust groups or clusters strategically positioned and clearly identified to facilitate follow-up maintenance.

- If planting individual trees or small groups, the use of tree shelters will promote growth and will also highlight the position of individual trees for follow-up maintenance (such as bramble control).
- Many considerations regarding afforestation also apply to conversion, e.g. appropriate species selection, the appropriate sourcing of forest reproductive material used, the need for minimum site inputs, measures to promote future wood production, the importance of grazing protection and vegetation management. See Section B9 AFFORESTATION.
- Note that tree felling generally requires a Felling Licence under the Forestry Act 2014, as set out in the Forestry Regulations 2017 (S.I.191 of 2017). See www.agriculture.gov.ie/forestservice/treefelling/ for details.

Management guidelines

- Identify opportunities for strategic conversion, both at an individual site level and also at the wider landscape level. This will focus effort and resources on sites where the greatest benefit can be achieved in terms of native woodland biodiversity, wider habitat linkage and the delivery of other ecosystem services, such as the protection of water.
- If converting non-native forest to native woodland, gradual transformation over a multi-year period using CCF is far better than abrupt replacement using clearfelling, in terms of the woodland ecosystem and wider sensitivities such as water and landscape. However, the latter approach may be the only realistic option on some sites, due to the risk of windthrow.
- Identify the most appropriate native woodland type for the site, based on factors such as soil, elevation and adjoining native woodland type(s). Subsequently, use this to determine which species of trees and shrubs to encourage, *via* natural regeneration and / or planting.
- Natural regeneration is the preferred method for generating new native woodland canopy on sites undergoing conversion. However, the degree of success will depend on the presence of suitable seed sources and management timelines.
- If planting, ensure that all forest reproductive material used is ecologically appropriate for the site and in compliance with regulatory requirements regarding traceability from source to planting site.
- The control of competing vegetation and protection against grazing will be critical factors in the emergent native canopy on conversion sites.
- In some parts of the country, high deer populations may pose extreme challenges to conversion, and control measures will be required.
- Proven seed sources, initial planting designs, stocking levels and shaping can all

lay down the foundation for future quality, where compatible wood production is a co-objective.

- Incorporate appropriate unplanted setbacks into the conversion process, in order to protect important non-woodland habitats, watercourses, archaeological sites and other sensitive features. Include other unplanted areas, as needed, to facilitate future management, e.g. access, deer control. The careful design and management of these open spaces – from orientation regarding sunlight to edge treatment – will contribute to the overall biodiversity of the converted woodland.
- Scots pine plantations can be managed to encourage the development of native species alongside retained pine. Larch can be treated similarly, but with the ultimate objective of replacing it with native species.

Examples of good practice

- Deputy's Pass Nature Reserve, Co. Wicklow: Conversion of former beech and conifer plantations to oak woodland.
- Vale of Clara Nature Reserve, Co. Wicklow: Removal of conifer stands and the development of mixed birch / oak woodland through natural regeneration.
- Derrycrag Nature Reserve, Co. Galway: Conversion of conifer stands to native oak woodland and thinning of Scots pine stands to encourage native species.
- Rosturra, Co. Galway: Conversion of conifer stands to native woodland through the planting of oak undertaken as part of the People's Millennium Forests Project.
- Shelton Abbey, Co. Wicklow: Replacement *via* the clearfelling of conifer stands and reforestation *via* planting and natural regeneration.

11. Products

Objectives: Where ecologically compatible:

- ***produce good quality wood and non-wood products; and***
- ***restore traditional forms of woodland management (coppicing and pollarding) and their associated habitats.***

Overview

The overriding objective regarding native woodlands is to manage for biodiversity and conservation. In many woodlands, however, the production of various wood and non-wood products using appropriate CCF (including traditional management systems) may be compatible with this primary objective. Where such opportunities exist, managing for compatible production should be encouraged, in order to generate an income stream for the woodland owner and to help offset the ongoing management costs of the woodland itself. Many native woodlands – both designated and non-designated – have an existing or potential economic value in this regard, and the growing and harvesting of products either for use on the holding itself (e.g. firewood, fencing material) or for income generation (e.g. the sale of marketable lengths of sawlog) may be a priority from the owner's perspective.

The wood production potential of our native woodlands is largely untapped. This was highlighted by the National Survey of Native Woodlands, which found the absence of good quality timber in many of the woodlands studied. Data collected showed that less than 4% of stems reached or exceeded a diameter of greater than 40 cm, and only 60% of these stems were of merchantable quality, i.e. without major defects.

The woodland type will dictate whether or not wood production is compatible and if so, the range of potential products possible. The rarity and ecological value of some

A former coppice of oak, with potential for coppice restoration. Vale of Clara Nature Reserve, Co. Wicklow.

woodlands, such as bog woodland and yew woods, generally rule out wood production as an objective. Production would also be limited within willow and alluvial woodlands, partly due to their rarity but also because of the nature of these sites and the heightened risk of soil disturbance and sediment runoff into watercourses. Woodlands on marginal sites (in terms of altitude, exposure, soil fertility and hydrology) may also have limited productive capacity. Some native woodlands have survived due to their relatively inaccessible location, and this remains as a constraint on wood production today. With these exceptions, however, most native woodlands can be managed for production, if the owner so wishes.

Wood production, when undertaken appropriately, is readily compatible with maintenance of the woodland ecosystem. However, it is still desirable to designate 5-10% of the woodland as minimal intervention areas, where the native canopy is allowed to develop naturally into old growth forest and where trees are allowed to complete their entire life cycle. These areas can be centred on the location of rare species, important sites for epiphytes and invertebrates, inaccessible areas or even on important non-woodland habitats, such as wetland. Large areas of minimal intervention may only be realistic in larger woodlands in which there is scope to introduce a variety of management practices. However, the potential exists in smaller woodlands too, and a woodland ecologist is best equipped to advise. Similar minimal intervention areas should also be designated in new emerging woodland, either planted or regenerating naturally (e.g. birch woodland on cutaway bog), in order to facilitate successional processes. Note that minimal intervention areas may still need management input, to control unnatural threats to woodland development posed by (e.g.) invasive rhododendron.

Note, tree felling generally requires a Felling Licence from the Forest Service – for details, see www.agriculture.gov.ie/forestservice/treefelling/.

Similarly, refer to the National Parks & Wildlife Service website www.npws.ie regarding details of any consent required if proposing to undertake certain activities within nature conservation areas such as SACs, SPAs, NHAs and pNHAs.

High quality oak felled for coopering within a native woodland sustainably managed under CCF. Ballytobin, Co. Kilkenny. (Photo P. Purser)

Wood production from non-native trees

At the commencement of any programme of native woodland restoration, a common operation is the removal of non-native trees. These may be present as single trees or as small groups within the existing native woodland canopy, or they may dominate entirely, e.g. a stand of Sitka spruce on an old woodland site. Removal and substitution with native trees should be as gradual as possible over a multi-year period, using CCF, in order to maintain woodland habitat conditions as far as possible. However, situations will arise where clearfell and reforestation (*via* planting and / or natural regeneration) will be the only viable option, normally due to concerns regarding windthrow. Both approaches are described further in Section B10: CONVERSION.

Whether gradual or immediate, the necessity to remove non-native trees creates an initial source of timber and other wood products, and associated revenue. Typically, harvesting and extraction costs will be higher, due to the sensitive nature of the site and the need to identify and protect native trees, where present. The selection of appropriate harvesting and extraction methods and machinery, and the careful layout and monitoring of extraction routes, will prove key in realising roadside timber without undue damage to the site. All aspects of the operation – from planning to implementation to afterworks – should be overseen by a qualified and experienced forester working closely with a woodland ecologist and a skilled forest contractor. Key aspects include the following:

- Identify and avoid sensitive areas of the site, such as watercourses and adjoining setbacks, refuge areas for woodland flora and fauna, etc.
- Assess existing access into the forest and determine whether or not additional forest roading is required.
- Select appropriate machinery to minimise site disturbance and damage to retained trees. Note that smaller machinery will cause significant damage if it is not capable of dealing comfortably with the tree sizes and / or site conditions involved.
- Set in place environmental contingency plans, for example, to ensure that all operations cease during and after heavy rain.
- Manage extraction routes, using brash material to protect against soil compaction and rutting.
- Locate all onsite machine refuelling and maintenance stations, fuel and chemical storage depots and timber stacking areas well away from water features and other sensitive areas.
- Implement post-operation works, including the removal of any temporary water crossings and the collection and appropriate disposal of all litter, empty oil containers, etc.

The Forest Service *Code of Best Forest Practice – Ireland* and environmental guidelines and requirements set out mandatory measures to protect (*inter alia*) biodiversity and water during forest road construction, thinning and harvesting. See www.agriculture.gov.ie/forestservice for details.

The range of products generated during this initial woodland restoration phase will vary greatly, from firewood and pulpwood to over-sized sawlog, both hardwood and

softwood. It is the role of the forester to accurately assess the value of the standing timber before operations commence, to grade the material accordingly and to secure the best price for the owner. In some situations, it may be worthwhile delaying the felling for a period of time, depending on fluctuations in timber prices. The felling of certain non-native trees may be delayed for a number of years or even decades, while they grow on to reach a more valuable timber size category. This option will be more viable for non-native species that do not regenerate vigorously and which have a degree of compatibility with the native woodland ecosystem, such as Douglas fir, Norway spruce and silver fir.

In all cases, decisions regarding the removal of non-native species, the methods used and time scales involved, must be driven primarily by what is needed to restore the woodland itself, and not solely by revenue considerations.

Wood production from native trees

Within woodlands dominated by native species, wood production compatible with biodiversity and conservation can be pursued through continuous cover forestry – see Section B10 CONVERSION for an overview of CCF.

Depending on its initial state at the commencement of CCF, considerable time may be needed before the woodland becomes fully 'productive'. The initial period may only yield limited – but still domestically useful and potentially profitable – volumes and assortments (e.g. for firewood, charcoal, craft products), while management gradually works towards improving the quality of larger selected stems.

Once the management system is fully established, CCF can provide the owner with a steady stream of quality timber (up to coopering grade and veneer grade) and associated income, potentially on an annual basis.

The main CCF systems appropriate within a native woodland context are selection, shelterwood and coppicing, all of which are outlined below. Within a particular woodland, a careful assessment of specific stand parameters and site conditions will indicate which approach is most suitable.

- **Selection** is a silvicultural system in which felling and regeneration are distributed over the whole stand and over time, with individual or small groups of large trees selected for felling in any single intervention. The selection system results in a continuous series of age classes and diameters, and an uneven-aged forest.
- **Shelterwood** aims to secure natural regeneration under the shelter of older trees, which are then removed by successive cuttings to allow the young trees to grow on to maturity. The system may be applicable to older, even-aged native woodlands where a range of age classes and greater species diversity are required. Variants include uniform, irregular, group and strip shelterwood.
- **Coppicing** is an ancient form of woodland management in which trees are cut just above ground level to encourage the production of multiple stems. These stems are then grown on and subsequently harvested after a number of years (depending on the stem diameter required for a particular end-use), thereby initiating a repeat of the cycle. Coppicing creates a range of habitats and light conditions within the forest, which benefits certain species of flora and fauna.

Group selection system in an ash-dominated woodland, Callan, Co. Kilkenny. (Photo P. Purser)

Uniform shelterwood system designed to introduce structural diversity into an even-aged oak-dominated woodland. Ballykilcavan, Co. Laois. (Photo H. Denman)

Variants include even-aged coppice, multi-aged coppice and coppice-with-standards (i.e. coppice stools interspersed with single-stemmed trees grown for sawlog). See below for further details.

Coppicing

Coppicing is an ancient form of forest management that was probably practised widely throughout Ireland over many centuries, although it is particularly associated with large estates (e.g. Carey, 2009). The principal species coppiced were oak, ash and hazel. The practice has largely disappeared, leaving extensive areas of 'derelict' coppice, old coppice-with-standards, or high forest, with various degrees of potential for restoration.

Coppicing can be considered as a management option:

- to create a particular type of habitat diversity within a woodland;
- to recreate an historic management system;
- to support a heritage craft; and
- to provide large volumes of small diameter wood products.

Well-managed coppice can promote structural and species diversity and encourage the natural regeneration of trees and shrubs. However, derelict coppice is typically poor in plant species, due to the dense shade and uniformity of structure, particularly where there is a lack of older trees as standards. Restoring coppicing may not produce the anticipated results and may be impractical if the stools are too old, as they may not re-sprout. Therefore, while the restoration of former coppice is desirable, it should only be pursued where silviculturally feasible and where adequate resources are in place to ensure the sustained level of intensive labour required. In most cases, restoration may only be viable locally and over small areas.

However, coppicing could be considered where the stand contains hazel and / or relatively young trees of other species. Large volumes of small diameter material suitable for a range of markets (e.g. firewood, charcoal, rustic products) can be produced, and this will offset to various degrees the costs involved. Care should be taken to ensure that rare invertebrates or epiphytic lichens and bryophytes (which may be growing on old stems) are not destroyed. This consideration applies particularly to hazel – see Section C5 Hazel Woodland. Grazing may inhibit regrowth: in the past, great efforts were taken to protect newly cut coppice from grazing animals, for example, by erecting barriers.

Advice and expertise regarding the viability of coppicing should be sought from organisations such as Muintir na Coille (www.muintirnacoille.ie).

Pollarding is similar to coppicing except that the trees are cut higher so that the new growth is out of the reach of grazing animals. The result is a tree with a short trunk

Hazel coppice stool and harvested hazel rods. Ballyvary, Co. Mayo.

A charcoal kiln during firing, Enniscoe, Co. Mayo. As well as supplying the barbecue market, charcoal derived from native woodlands is also used for specialist metal work, experimental archaeology and as artist charcoal. (Photo J. Gowran)

A replica of a Viking dwelling at the Irish National Heritage Park, Ferrycarrig, Co. Wexford, based on dimensions from archaeological digs in Dublin and Wexford. The dwelling was constructed by Muintir na Coille during 2012 and 2013, using small diameter material sourced from native woodlands. (Photo J. Gowran)

and a multiplicity of branches. Pollarding was more often practised in wood pasture or along hedgerows, although old pollards can be found today inside woodlands. On conversion sites involving the clearfell of an existing conifer crop and subsequent reforestation with native woodland, pollarding can be applied to existing broadleaves surviving within the canopy, to avoid their windthrow following the removal of the surrounding conifers. It also encourages branching and early seeding of the retained trees, thereby adding to the structure of the replacement native woodland emerging onsite (Coillte, 2009).

Non-wood products

Many native woodlands may also have the potential for producing a wide range of 'non-wood' products and services, generating additional revenue to fund ongoing woodland management. These include wildlife game, foliage, berries, mushrooms, herbs, seed, bark, resins, dyes and craft material.

Readers are directed to Collier *et al.* (2004) for further details, and also to the ForestHarvest website www.forestharvest.org.uk, which describes income opportunities based on Scotland's wild and woodland products.

The provision of amenity (e.g. within the context of a woodland / parkland setting with onsite accommodation or a visitor attraction) is also a possibility, and is explored further in Section B12: AMENITY AND INTERPRETATION.

As with wood production, realising the potential for non-wood products and services is only encouraged where compatible with the woodland ecosystem and site conditions. The potential for damage is real (e.g. soil eutrophication from pheasant rearing) and the input of a woodland ecologist is essential.

Management guidelines

- Within native woodlands, wood and non-wood production should only be considered where it is compatible with the primary objective regarding biodiversity and conservation, and with site conditions.
- The potential for wood production will depend firstly on the ecological suitability of this option, and secondly, on stand parameters such as species composition, stem diameter and access. This will require the combined input of a woodland ecologist and a forester, the latter to undertake an inventory and to draw up a plan to realise this potential over time, through appropriate silvicultural interventions.
- Timber and other wood products can be realised through the felling of non-native trees as part of a programme to restore a native woodland site. Ideally, this programme should be carried out gradually using CCF, to protect the woodland ecosystem. However, in some cases, clearfelling is unavoidable.
- In all cases, decisions regarding the methods used and time scales involved must be driven primarily by what is needed to restore the woodland itself, and not solely by revenue considerations.
- Wood production from native species can be pursued on an ongoing basis, through the application of CCF systems, namely selection, shelterwood and coppicing. Often, considerable time is needed before the woodland reaches its full productive potential.
- Secure the input of a professional forester who has the necessary silvicultural expertise regarding CCF, experience of harvesting and extraction on sensitive sites, and good knowledge of potential markets. This will maximise the woodland's economic value while retaining its ecological and biodiversity value.
- Maintain or restore traditional management, where possible and appropriate (e.g. coppicing – see below).

- Regarding coppice:
  - Where there is a good chance of success, restore abandoned coppice or coppice-with-standards. Small areas should be selected and coppiced on a rotational basis of *c.*20 years for oak, 12 years for ash and 7-10 years for hazel, depending on target diameters and intended markets.
  - Where there is little chance of successful rejuvenation of the coppice, either leave the stand unmanaged or manage as high forest, identifying and favouring better stems as potential timber trees.
  - As an alternative, derelict coppice stools could be cut and the area either replanted with appropriate species to create new coppice or high forest, or managed to allow natural regeneration from seed to develop.
  - Take cognisance of rare or uncommon invertebrates, birds or plants (including lichens and bryophytes) that may be adversely impacted by coppicing.
  - The control of grazing will be required following the coppicing, as new shoots emerge.
  - If attempting to restore a derelict coppice woodland, or to establish a new coppice woodland, consult with relevant experts about the management prescription best suited to the woodland type, species, site conditions and potential markets.
- If planning a new native woodland that includes wood production as an objective, issues such as access, species selection, seed source, planting density, protection and shaping all play an important role in determining future quality. See Section B9: AFFORESTATION.
- Certain woodland types will not be suitable for wood production, due to their rarity and / or inherently vulnerable site conditions, e.g. sensitive soils, high watertable.
- In woodlands where production is being pursued, retain approximately 5-10% as minimal intervention areas, within which, trees are allowed to complete their entire life cycle. These areas are best identified by a woodland ecologist.
- Similarly, it is important to leave deadwood within the woodland. This may entail leaving sections of marketable material lying on the forest floor, and a selection of mature and over-mature trees left standing. See Section B8: DEAD AND DECAYING WOOD.
- The production of non-wood products and services should be sustainably based, depending on the specific capacity of the woodland.

Examples of good practice

- Ballykilcavan, Co. Laois: Restoration of native woodland through the removal of conifer stands and the encouragement of natural regeneration combined with the planting of native species for timber production.
- Ballyvary, Co. Mayo: Restored hazel coppice.

- Cloragh, Co. Wicklow: Example of a shelterwood system in practice.
- Castleblunden, Co. Kilkenny: Example of a selection system in practice.

12. Amenity and Interpretation

Objective: Facilitate the appropriate use of native woodlands for outdoor recreation and interpretation, in order to increase the enjoyment, understanding and appreciation of this key component of Ireland's natural and cultural heritage.

Overview

Native woodlands represent a significant resource for outdoor recreation and for learning about the diversity of woodland ecosystems and about the environment in general. They provide people of all ages and abilities with direct contact to the natural world and the changing seasons, promoting health and well-being. Native woodlands also represent the perfect outdoor classroom for children and adults of all ages to learn about the natural, historical and cultural aspects of this part of the Irish landscape. In addition, they provide ample opportunities for 'natural play', allowing children to intuitively learn about the natural world through playful interaction with its components. The emphasis on healthy and sustainable living, outdoor recreation and awareness of our heritage points towards an increasing demand for accessible 'close-to-nature' amenities such as native woodlands, particularly those within easy reach of local population centres or as part of wider visitor attractions, walking trails or tourist routes.

Such use may also create the potential for income generation for the woodland owner, and resources for the ongoing management of the woodland. For example, native woodland might form part of the setting for a wider amenity involving holiday accommodation, adventure sports or a 'pay-to-enter' visitor attraction, or for some other income-generating recreational pursuit.

Poulgorm, Glengarriff, Co. Cork, a native woodland restored through a community-based initiative, for use as an outdoor amenity and educational resource by local people.

Some native woodlands are already used unofficially for outdoor recreation, and owners may have to decide to cater for this *de facto* use on a more structured basis, to better manage the issue.

However, the use of native woodlands for amenity purposes (and to a lesser extent, for interpretation purposes by schools) can pose a significant threat to the woodland ecosystem, through overuse and disturbance. Damage can arise through excessive trampling, littering, wildlife disturbance (e.g. by dogs), the importation of non-native flora from gardens, and fire. Malicious acts can also occur. Therefore, such use will not be appropriate for all native woodlands, or for all areas within individual woodlands, depending on a variety of factors including ecological sensitivity, size and associated 'carrying capacity'. Any decision to develop a native woodland for amenity must be based on an assessment and ongoing monitoring by a woodland ecologist, and the input of the National Parks & Wildlife Service, where protected habitats and species are involved. For example, in sensitive, high biodiversity value woodlands, visitors may need to be restricted to tracks and pathways.

Where recreational use is proposed and appropriate, woodland owners and managers should follow available guides setting out good practice, to enhance the experience of the visitor as s/he enjoys and learns more about the woodland. This will also help to avoid possible pitfalls, such as the installation of poorly-designed paths and facilities unsuited to the woodland setting.

Numerous good practice guides are available, offering a wealth of relevant information. Readers are initially directed to the Forest Service *Forest recreation in Ireland: A guide for forest owners and managers* (DAFM, 2006), which sets out information on forest recreation, including: consultation and planning; legal responsibilities; advice on the layout and design of pathways, signs and other facilities; the use of open spaces; recreational issues such as promotion, interpretation, safety and security; and dealing with vandalism and other undesirable activities. It also lists relevant initiatives and organisations and further sources of information. Various community-based projects supported under the Forest Service NeighbourWood Scheme also provide invaluable case studies for the development of native woodlands for amenity and interpretation.

Management guidelines

- Be very clear about the level and type of recreational use appropriate to the woodland. This decision will be based on (*inter alia*) the woodland's ecological sensitivity and attributes, demand (both existing and predicted), user preferences, access and available resources.
- Aim to provide trails and facilities that are durable and high quality, in keeping with the woodland setting and appropriate to the type of recreation being catered for (e.g. use by parents with toddlers versus outdoor walking groups).
- Aim to develop the amenity in consultation with user groups. This usually involves the local community, but other specific groups may be relevant, such as birdwatchers or outdoor sports clubs. Meaningful consultation yields multiple benefits, leading to a woodland amenity that is tailored to people's needs and preferences and recognised as an important community resource to be looked after by all. See Van Herzele *et al.* (2005) for ideas on how to creatively engagement with communities.

Into the Dark *by artist Eileen MacDonagh, made from cherry laurel cut from surrounding native woodland. Part of the former 'Sculpture in Woodland' collection in the Coillte-owned Devil's Glen Forest, Co. Wicklow.*

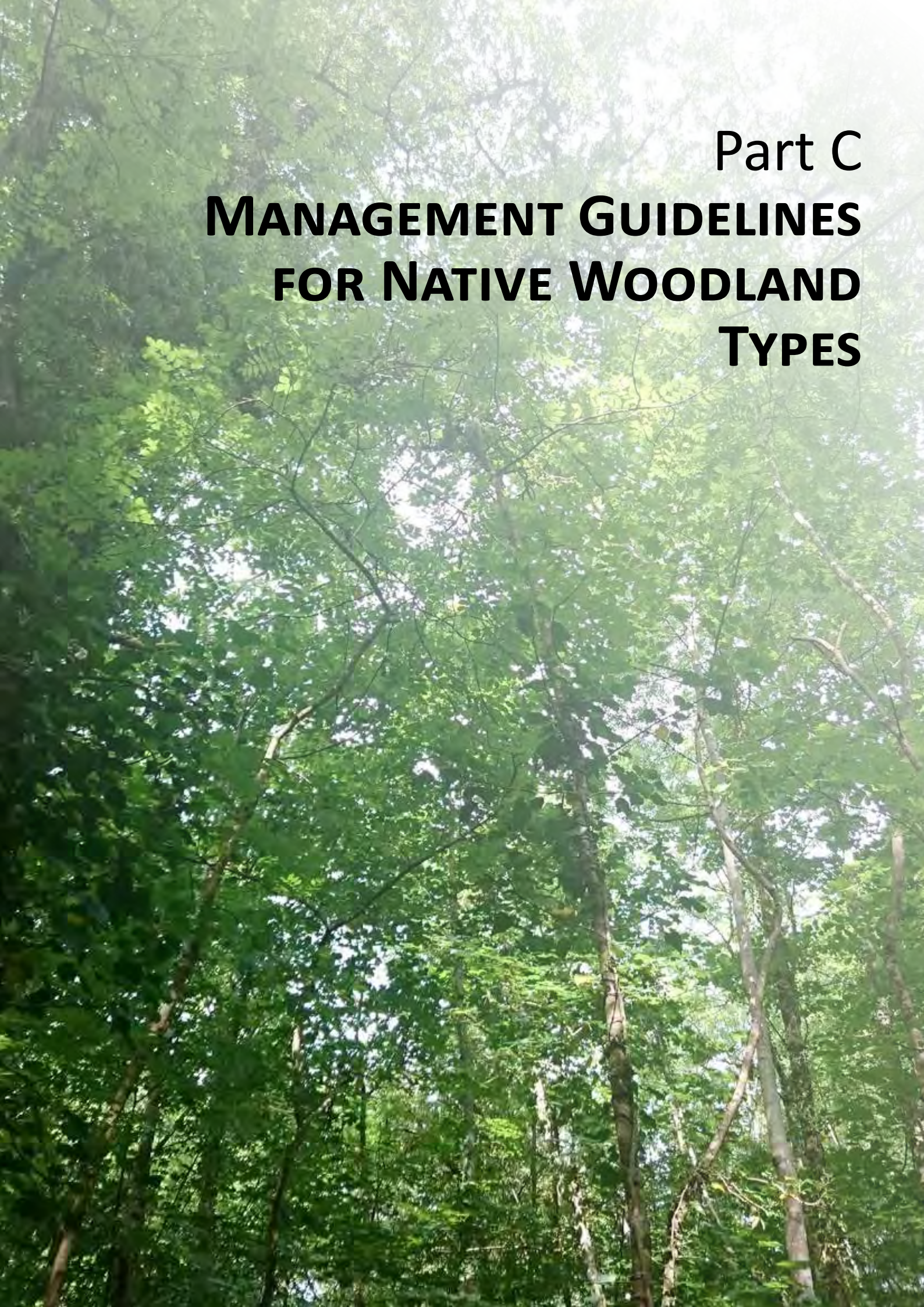
- As part of the above process, focus particularly on providing access for all, to enable people with as wide a range of abilities as possible to enjoy the woodland. This consideration should permeate all aspects, from the layout and design of walks and facilities to the promotion of the woodland through leaflets and on the web. Routes focused on tactile experiences can be particularly inclusive. Consult with relevant representative bodies and local action groups, and with organisations specialising in the provision of countryside access for all, such as the UK's Fieldfare Trust (www.fieldfare.org.uk).
- Adopt a clear and concise code of practice for visitors using the woodland. This is particularly important in the case of native woodlands, given their ecological sensitivity. Leave No Trace Ireland is an organisation promoting ethical outdoor recreation, based on a clear and concise code of practice – see www.leavenotraceireland.org for further information.
- The use of the woodland as an educational resource opens up significant opportunities for engagement, particularly with school groups, young people and families. Any information presented should be accurate and based on an ecological assessment of the woodland itself. Onsite information, specialised interpretive facilities, downloadable nature guides and 'walk-and-talks' by local experts (e.g. birdwatchers, historians) are all suitable options, alongside direct engagement with local schools.
- Catering for amenity and recreation within a native woodland is a highly specialised endeavour. Therefore, seek professional advice from an outdoor recreation specialist, an ecologist and a forester, and be aware that this type of use may not be viable or appropriate in many situations.

Examples of good practice

- Balrath Woodland, Kentstown, Co. Meath: An outdoor classroom managed by

the Tree Council of Ireland in partnership with Meath County Council.

- Poulgorm, Glengarriff, Co. Cork: A community project involving the restoration of an existing native woodland overrun with rhododendron, and the installation of pathways, signage and other recreational facilities, under the Forest Service NeighbourWood Scheme.
- Fitzsimon's Wood, Sandyford, Co. Dublin: A native woodland within the urban context, developed by Dún Laoghaire-Rathdown County Council and the local community.



Part C
Management Guidelines for Native Woodland Types

1. Oak (*Quercus petraea*) Woodland

Overall description

Sessile oak woodlands occur principally on acidic, well-drained mineral soils, mostly podzols (pH typically *c.*4.5), frequently on hillsides and valley sides in upland areas. Many are mature high forests characterised by a dominance of oak, mostly sessile oak but sometimes pedunculate oak or hybrids between the two species. Downy birch and rowan also occur in varying quantities. The shrub layer, which is typically dominated by holly, may be poorly developed due to overgrazing or may form dense stands, especially following a relaxation of grazing pressure. Holly is characteristically replaced by hazel on more fertile soils, where ash may also occur. A dwarf shrub layer of bilberry and sometimes ling heather is typically present. The herb layer is usually species-poor and often dominated by woodrush with abundant ferns, e.g. hard fern, common polypody and bracken. Species such as bluebell occur where the soil is more fertile, e.g. beside streams or at the base of slopes. Many of these woodlands, particularly in the west of Ireland and in sheltered humid sites elsewhere, are noted for the richness and luxuriance of the mosses, liverworts and lichens.

Many of these woods have been heavily managed in the past, and the dominance of oak may be a reflection of this history. Stands are often uniform in age, and many may have arisen from former coppice or coppice-with-standards. They are commonly overgrazed and consequently have a poorly developed field layer and lack regeneration. Beech is frequently present (although usually in small quantities), as are isolated specimens of old conifers, particularly Scots pine and larch. Rhododendron is often abundant, especially in areas of high rainfall. Cherry laurel and other non-native shrubs may also

Sessile oak woodland with birch, holly and a herb layer of woodrush and bracken. Vale of Clara Nature Reserve, Co. Wicklow.

(Left) Hard fern, Rostura Wood Nature Reserve, Co. Galway.

(Right) Wood sorrel, Ullaun's Wood, Killarney National Park, Co. Kerry.

be present on better soils. Deadwood is relatively abundant, particularly in the form of large, old stag-headed trees and occasionally as standing and fallen deadwood. Animal life is often diverse, particularly in the case of invertebrates.

Many stands only contain trees of firewood quality, with perhaps a few stems of timber quality. From a wood quality perspective, such stands may be improved in the long term, by selective felling or conversion to high forest, in the case of abandoned coppice. Due to the inherent infertility of soils often associated with oak woodland, stand improvement for wood quality may take many years, and there may be a limit regarding what can be achieved with oak itself. In such situations, other associated species may offer greater potential. These includes birch, which is a pioneer species present during the early successional stages of this woodland type.

Characteristic features

- Dominance of oak in the canopy.
- Holly may dominate the shrub layer.
- The field layer is often poor, except on better soils.
- Bryophyte, lichen and epiphytic flora may be rich.
- Large old trees may be present.
- Rich invertebrate fauna.
- May be a variety of deadwood in varying quantities.
- Often little natural regeneration.
- Often overgrazed, particularly in upland areas.
- Often little timber of merchantable quality.
- Invasive non-natives often present (rhododendron, beech, locally cherry laurel).

Management guidelines

- Maintain a canopy of greater than 85%, to retain high humidity levels for bryophytes and lichens.
- Native species should account for 90% or more of the canopy. Non-native species can be tolerated as long as they are not too aggressive. The retention of any non-native veteran trees present may be considered, due to their potential habitat value. However, it may be necessary to control associated regeneration, for example, in the case of beech.
- If the understorey comprises very dense holly, it may be necessary to apply thinning in order to encourage other species and the herb layer.
- Maintain sufficient canopy cover to prevent bramble from dominating.
- Monitor for early evidence of invasive non-native species, particularly rhododendron. If discovered, apply aggressive control promptly and thoroughly, to prevent such species gaining any foothold within the woodland.
- If invasive exotics are already present, develop and implement a multi-year plan of control and follow-up monitoring and treatment, based on established best practice.
- Large, even-aged stands (>10 ha) could be opened up or thinned to diversify their structure, where this would benefit biodiversity and is compatible with other objectives.
- Retain large old trees. They should only be felled following careful assessment confirming that they do not carry any important population of epiphytes, invertebrates, bats, etc.
- Ensure a range of different types and sizes of deadwood. In particular, retain veteran and moribund trees and if necessary, create additional deadwood.
- Ensure that the protection of features and indicators of local distinctiveness

Epiphytes, Tomies Wood, Co. Kerry.

(e.g. rare species, flushes) is factored into management objectives.

- Focus afforestation and conversion efforts on connecting existing stands, particularly if they are small or located along watercourses.
- Windthrown trees should not be cut or removed unless they pose a safety risk or create access difficulties. If such trees are still rooted, existing branches will form new stems.
- Where the potential exists, manage stands for wood production using an appropriate continuous cover forestry system, taking care not to damage important epiphytic communities.
- Where appropriate and possible, restore traditional management practices over small areas.
- Ensure that grazing pressure is managed in order to allow the development of a well-structured wood. If overgrazing occurs, control animal numbers and / or erect exclosures. If undergrazed, a carefully-controlled regime allowing some grazing for short periods in the winter, will facilitate the opening up of dense undergrowth.

2. Ash Woodland

Overall description

While showing a great deal of variation, ash woodlands typically comprise mixed stands of ash, hazel and pedunculate oak on relatively dry to moist, mostly base-rich (pH typically *c.*5.9) mineral soils in lowland areas. Woodlands dominated by ash and hazel are the most common woodland type in the lowlands of Ireland (Perrin *et al.*, 2008). The canopy is more varied than oak woodlands: ash is typically the dominant tree, often with pedunculate oak and (characteristically) some birch, rowan and cherry, as well as introduced beech and sycamore. Although not always dominant, hazel is typically the most common species within the shrub layer, and there are frequently small amounts of hawthorn, holly, spindle and blackthorn. The introduced cherry laurel can form dense thickets locally. Ash woodlands are generally much richer in flowering plants than sessile oak woodlands. They often have a colourful spring flora, with species such as bluebell, anemone, primrose, violet, celandine and orchids (e.g. early purple orchid). Though locally common (particularly in rocky woods in the west of Ireland), mosses and liverworts are generally less abundant and varied than oak woodlands.

Like the sessile oak woodlands, many ash woodlands have been heavily managed in the past. In contrast, however, the pedunculate oak component may have been selectively removed, leaving ash as the main canopy species. Stands tend to be of variable age and show considerable structural diversity. They are less likely to be overgrazed than sessile oak woodlands and consequently, have a well-developed field layer and often good regeneration, especially of ash. Beech and sycamore are frequently present, along with isolated specimens of old conifers. Rhododendron is only occasional, but cherry laurel may form dense thickets. Deadwood is relatively abundant, particularly in the form of large, old stag-headed oak trees and occasionally as standing and fallen deadwood. Animal life is often diverse, particularly in the case of invertebrates and birds.

Tutsan, a typical species of ash woodlands. Coole-Garryland Wood Nature Reserve, Co. Galway.

Regarding wood production, timber quality trees may be present, mainly pedunculate oak and ash. In many stands, however, the best timber has already been removed. There is the potential to improve this situation by thinning regeneration, and stand improvement may occur relatively quickly.

Considerable concern exists regarding Chalara or Ash Dieback disease, caused by the fungus *Hymenoscyphus fraxineus*. As well as threatening the future of ash as a valuable fast-growing hardwood species, it poses a significant threat to many native woodlands in which ash represents an important component. Numerous species of flora and fauna are supported by ash, many uniquely so, and the level of ecological impact the disease may have in Ireland's native woodlands is as yet unclear. For further information, see www.agriculture.gov.ie/forestservice/treediseases/.

Characteristic features

- Large old pedunculate oak and ash may be present.
- Hazel typically dominates the shrub layer.
- Field layer is typically species-rich.
- Bryophyte and lichen flora are usually poorly developed.
- Regeneration is usually better than in sessile oak woodlands.
- Rich invertebrate fauna.
- May be under- or overgrazed.
- Variety of deadwood in varying quantities.
- Invasive non-natives often present, including cherry laurel, beech and sycamore, with rhododendron, snowberry and other species occurring locally.
- Timber quality trees (mostly pedunculate oak and ash) more often present than in sessile oak woods.

Management guidelines

- Maintain a minimum canopy cover of 70%. The canopy should be sufficiently open to allow the regeneration of ash and oak, but not so much that bramble or bracken begin to dominate.
- Native species should account for 90% or more of the canopy. Non-native species can be tolerated as long as they are not too aggressive. The retention of any non-native veteran trees present may be considered, due to their potential habitat value. However, it may be necessary to control associated regeneration.
- If a particular species within the understorey (e.g. hazel) becomes very dense, it may need thinning in order to encourage other species (if present) and the herb layer. (Also see Section C5 HAZEL WOODLAND).
- Maintain a well-developed and diverse herb layer.
- Control invasive exotic species, particularly cherry laurel, beech and sycamore.
- Stand structure is usually better developed than that in sessile oak woodlands.

*Charleville Wood, Co. Offaly. A well-documented ancient ash – ivy woodland of mixed oak (*Quercus robur*) and ash with a species-rich ground flora, here dominated by bluebell and celandine.*

However, it may need diversifying, particularly if there is a predominance of young ash or mature trees.

- If the felling of any large old tree is being considered, undertake a careful assessment to ascertain whether or not it supports any important population of epiphytes, invertebrates, bats, etc.
- Ensure a range of different types and sizes of deadwood. In particular, retain veteran and moribund trees and if necessary, create additional deadwood.
- Ensure that the protection of features and indicators of local distinctiveness (e.g. rare species, flushes) is factored into management objectives.
- Focus afforestation and conversion efforts on connecting existing stands, particularly if they are small or located along watercourses.
- Windthrown trees should not be cut or removed unless they pose a safety risk or create access difficulties. If such trees are still rooted, existing branches will form new stems.
- Many of these stands have the potential for producing good quality large diameter timber of ash or oak, under CCF. Even poorer quality stands should be capable of providing hurley lengths and / or small diameter wood products (including small sawlog) in the medium term.
- Where appropriate and possible, restore traditional management practices over small areas.
- Ensure that grazing pressure is managed in order to allow the development of a well-structured wood. If overgrazing occurs, control animal numbers and / or erect exclosures. If undergrazed, a carefully-controlled regime allowing some grazing for short periods in the winter, will facilitate the opening up of dense undergrowth.

3. Alder Woodland

Overall description

Alder woodlands are species-rich woodlands characteristic of poorly drained gleys, flushes, stream and river margins, lakeshores and water-logged hollows (pH typically *c.*6.2). The canopy is dominated by alder, sometimes with ash and sally, both of which may often occur in the understorey. The herb layer is very rich in species, with an abundance of moisture-loving herbs, e.g. meadowsweet, remote sedge, marsh bedstraw, angelica, creeping buttercup, water mint and yellow flag. This woodland type is distributed throughout the country but is particularly associated with drumlins and river valleys.

Alder woodlands are rarely managed for wood production. They may be open with a thin canopy and poorly developed shrub layer, or may have a dense and sometimes tangled shrub layer of fallen willows. They tend to be young with few large old trees. They often have a well-developed field layer and are only rarely overgrazed (if so, mainly by cattle). Sycamore may be present and red-osier dogwood can form dense thickets locally. Animal life is often diverse, particularly in the case of invertebrates.

Characteristic features

- Often young woods.
- Large trees are rare.
- Canopy may be mixed or dominated by alder, and is typically thin.
- Shrub layer may be well-developed and sometimes comprises a tangle of fallen willows.

Alder woodland with sally, and tussock sedge and yellow flag in the herb layer, Abbeyleix, Co. Laois.

- Field layer is often well-developed, luxuriant and species-rich.
- Bryophyte and lichen floras may be species-rich, although often poorly developed.
- Rich invertebrate fauna.
- Rarely overgrazed.
- Hydrological conditions are a central factor in maintaining the woodland ecosystem.
- Deadwood is mostly small diameter in nature.
- Invasive non-natives include red-osier dogwood and sycamore, with rhododendron, Himalayan balsam, giant hogweed and Japanese knotweed occurring locally, particularly along watercourses.
- Wood of commercial quality is rarely present.

Management guidelines

- Maintain a minimum canopy cover of 70%. Stand structure may be naturally open due to hydrology.
- Native species should account for 90% or more of the canopy. The retention of any non-native veteran trees present may be considered, due to their potential habitat value. However, it may be necessary to control associated regeneration.
- There is seldom a necessity to thin or remove the understorey, although it may be desirable alongside river channels to facilitate anglers.
- Maintain sufficient canopy cover to prevent bramble from dominating.
- Control invasive exotic species, especially red-osier dogwood, Himalayan balsam and Japanese knotweed. Regarding invasives along rivers and streams,

Guelder rose with flowers and berries, a typical shrub of alder woodlands.

where best practice involves herbicide use, consult with Inland Fisheries Ireland and other relevant bodies in advance. Controlling such species is difficult and expensive, and often requires a wider catchment approach for progress to be sustained.

- Stands are often small and young and rarely need to be managed to increase diversity.
- If the felling of any large old tree is being considered, undertake a careful assessment to ascertain whether or not it supports any important population of epiphytes, invertebrates, bats, etc.
- Ensure a range of different types and sizes of deadwood. In particular, retain veteran and moribund trees and if necessary, create additional deadwood.
- Ensure that the protection of features and indicators of local distinctiveness (e.g. rare species) is factored into management objectives.
- Focus afforestation and conversion efforts on connecting existing stands, particularly if they are small or located along watercourses. However, leave patches of fen, marsh, etc. undisturbed, as these will form natural clearings.
- Windthrown trees should not be cut or removed unless they pose a safety risk or create access difficulties. If such trees are still rooted, existing branches will form new stems.
- Where the land is not too wet, there is the potential for small diameter wood production, using appropriate CCF. However, in general, a setback of at least 15 metres should be maintained along the watercourses, within which felling is excluded.
- Where appropriate and possible, restore traditional silvicultural management practices over small areas.
- Ensure that grazing pressure is managed in order to allow the development of a well-structured wood. If overgrazing occurs, control animal numbers and / or erect exclosures.

4. Birch Woodland

Overall description

Birch woodlands occur on degraded or intact raised bogs and in peaty hollows, and locally on mineral soils (pH typically *c.*4.6). These woodlands are dominated by birch, often with very few other tree or shrub species present (although Scots pine may be abundant locally). They are typically species-poor, with the principal herbaceous species being purple moor-grass, bramble and broad buckler-fern and sometimes, mono-dominant stands of bracken. Mosses and liverworts may be abundant but lack diversity of species.

Birch woodlands are principally associated with cutaway (locally intact) raised bogs but also occur in association with sessile oak or ash woodlands, either as inclusions or as an early successional stage following felling or windthrow. Characteristically, they are even-aged and rather open. On poorer soils, dead and moribund trees produce gaps in the canopy. The natural succession within birch stands on acidic peats is not clear. On more fertile soils, however, other tree species are likely to replace the birch in the long term.

Birch is currently not highly valued for its wood in Ireland. Consequently, these woodlands are rarely managed, although they often have the potential for producing small diameter timber and other wood products. They are also seldom overgrazed. Thinning and inter-planting could be undertaken where possible wood production is being sought, but in general, it is best to allow natural processes to occur.

Characteristic features

- Mostly young woodlands that are still developing naturally.
- Often early successional stage to sessile oak or ash woodland.

Wet birch woodland with a well-developed moss layer, Glendalough, Co. Wicklow.

Dry birch woodland, Deputy's Pass Nature Reserve, Co. Wicklow. This stand, originated from natural regeneration following conifer clearfell, has been thinned under CCF to favour better quality timber stems. (Photo D. Little)

- Light, open canopy dominated by birch.
- Stand structure is often even-aged.
- Understorey is often poorly developed and thin.
- Field layer is typically species-poor, particularly on peat.
- Bryophyte and lichen floras are mostly poorly developed and species-poor, except in bog woodland.
- Rarely many large trees.
- Seldom overgrazed.
- Mostly small quantities of small diameter deadwood, except in bog woodland where there may be larger quantities.
- Hydrology is very important in maintaining bog woodlands.
- Invasive non-native species are relatively uncommon, but rhododendron occurs locally on drier sites.
- Often little regeneration.
- Generally, poor tree form limits the potential for timber production.

Management guidelines

- Maintain a minimum canopy cover of 70%.
- Native species should account for 90% or more of the canopy. Non-native species can be tolerated as long as they are not too aggressive. The retention of any non-native veteran trees present may be considered, due to their potential habitat value. However, it may be necessary to control associated regeneration.
- Generally, there is little to be gained ecologically in attempting to manage birch stands. Instead, it is often better to allow natural succession to occur. However, stands could be diversified by thinning, to encourage the natural regeneration of other tree and shrub species and the development of the understorey. Note that some stands on peat may represent the climax vegetation.

- Control invasive exotic species, especially rhododendron, which can become a serious threat if not controlled in its early stages of invasion.
- If the felling of any large old tree is being considered, undertake a careful assessment to ascertain whether or not it supports any important population of epiphytes, invertebrates, bats, etc.
- Ensure a range of different types and sizes of deadwood. In particular, retain veteran and moribund trees and if necessary, create additional deadwood.
- Ensure that the protection of features and indicators of local distinctiveness (e.g. rare species, patches of heath or bog) is factored into management objectives.
- Focus afforestation and conversion efforts on connecting existing stands, particularly if they are small or located along watercourses.
- Windthrown trees should not be cut or removed unless they pose a safety risk or create access difficulties. If such trees are still rooted, existing branches will form new stems.
- Where the potential exists (usually only on mineral soils), consider managing stands for small to medium diameter wood production, using CCF. Significant potential may existing in this regard.
- Ensure that grazing pressure is managed in order to allow the development of a well-structured wood. If overgrazing occurs, control animal numbers and / or erect exclosures. A carefully-controlled grazing regime using ponies or cattle may be beneficial in facilitating the opening up of dense undergrowth.

5. Hazel Woodland

Overall description

Recently published work undertaken in Scotland (Coppins & Coppins, 2012) has changed our perception of hazel. This work suggests that hazel is much more than a 'mere' shrub and does in fact naturally form pure woodland in which other tree species are never more than a minor constituent. Although hazel growing in open situations will readily regenerate from seed, trees in shaded situations are not very fertile. Individual trees regenerate vegetatively by producing new stems that constantly replace old and moribund stems. Coppins & Coppins (2012) postulate that, as a result, individual stools expand outwards to form rings of stools, all genetically identical. Thus, individual hazel stools may be many hundreds of years old and the hazel woodlands themselves may be very ancient. These are referred to as 'Atlantic Hazel Woodland'.

The herb layer of these woodlands is typically rich in species, with an abundance of spring-flowering plants characteristic of ash woodlands, including wood avens, wood sorrel, bluebell, violets, barren strawberry, bramble, ivy and broad buckler-fern. Of greatest significance, however, are the epiphytic bryophytes and in particular, the lichens. There appears to be a well-defined succession of lichens on hazel stems. The smooth bark of young stems is colonised by a range of crustose lichens forming pale-coloured mosaics. These include the so-called 'script' lichens (*Graphis* species), which resemble writing or scribble. As stems age, their bark becomes rougher and is colonised by mosses and liverworts and a different suite of lichens. Old fissured stems are colonised by a profusion of bryophytes and leafy-lobed lichens, such as tree lungwort (*Lobaria pulmonaria* L. (Hoffm.)). In addition, there are several fungi which appear to be unique to hazel, such as the glue fungus (*Hymenochaete corrugata*), which stick twigs and branches together, and hazel gloves fungus (*Hypocreopsis rhododendri* Thaxt.), which resembles fingers grasping the branches.

Recently coppiced hazel, possibly suitable for re-coppicing on a 5-year cycle. St. John's Wood, Co. Roscommon.

It is not clear to what extent Atlantic Hazel Woodland occurs in Ireland. There is extensive low-growing hazel woodland in the Burren, and while much of this is relatively young, there are 'core' stands of much older woodland. In these, hazel is dominant and other species, such as willow, ash and hawthorn, are only minor components showing no tendency to spread at the expense of hazel. The herb flora is typically species-rich, and characteristic species of bryophytes and lichens are also present, chiefly in old stands. Glue fungus and hazel gloves fungus are also present. However, these woodlands are apparently less diverse than their Scottish counterparts, and some of the rarer species of lichen are either absent or as yet undiscovered.

Similar hazel woodland occurs elsewhere on limestone pavement and may occur on other substrates, but such woodland does not appear to be comparable with that in the Burren or as described in Scotland. However, oak and ash woodlands containing abundant hazel are common throughout Ireland, and similar epiphyte communities are also present, particularly in the west of the country and in humid locations elsewhere.

Hazel woodland is particularly suited to coppicing, owing to the ability of individual trees to regenerate vegetatively by replacing old and moribund stems with new growth. This opens up the possibility for producing small to medium diameter material suitable for a wide range of wood products, from firewood and charcoal to wattle fencing, rustic products and craftwork. The capacity of individual stands to undergo coppice management various greatly, as described in Section B11 PRODUCTS.

Characteristic features

- Comprises largely of relatively low-growing, multi-stemmed hazel.
- Canopy typically casts dense shade.
- Stand structure is often even-aged and relatively young, but old stands or individuals may be included.
- Little regeneration of either hazel or other species by seed under the dense canopy. However, hazel has an ability to constantly regenerate vegetatively by producing basal shoots.
- Field layer is often species-rich.
- Bryophyte, lichen and fungal flora are often well-developed and include rare species.
- May be used as wood pasture.
- Mostly small quantities of small diameter deadwood.
- Invasive aliens such as beech and sycamore are often present in small numbers. Rhododendron can occur on non-calcareous soils.

Management guidelines

- Native species should account for 90% or more of the canopy. Non-native species can be tolerated as long as they are not too aggressive. The retention of any non-native veteran trees present may be considered, due to their potential habitat value. However, it may be necessary to control associated regeneration.

(Left) Glue fungus sticking two branches together, Glenveagh National Park, Co. Donegal.

(Right) Hazel gloves fungus, Keelhilla Nature Reserve, Burren.

- Epiphytic communities require continuity of habitat. Felling stems carrying these communities not only destroys the epiphytes themselves, but also eliminates the source of spores that may otherwise colonise other trees. Therefore, cutting hazel trees with large or old stems, particularly those carrying leafy-lobed lichens, should be avoided.
- Most hazel stems carry crustose lichens, but check in particular for the presence of leafy-lobed lichens and / or glue fungus and hazel gloves fungus.
- Coppicing is a valuable management tool for increasing diversity within a hazel woodland. Before commencing a coppice regime, however, be very clear about the objectives and be certain that the process will enhance the biodiversity value of the stand.
- If hazel is dominant as a shrub layer under a higher canopy to the extent that the forest floor becomes shaded, coppicing could be beneficial in stimulating the herb layer, encouraging regeneration and providing habitat for invertebrates. In such sites, the localised loss of the bryophyte, lichen and fungal flora might be acceptable provided there are other similar stands from where these species can recolonise.
- If felling is unavoidable, ensure that a sufficient number of trees are left to maintain a diversity of stems and their associated habitats.
- It is preferable to concentrate coppicing on stands of small hazel trees (i.e. those without large or old stems) and on re-cutting existing coppice.
- Opening up the woodland changes the micro-climate and may indirectly damage or destroy epiphytic communities on trees in adjacent areas. Avoid felling any tree that may be casting shade on sensitive lichen communities present on the stems of nearby hazel (or any other tree species).
- Control any invasive exotic species.
- Ensure the presence of different types of deadwood. However, note that

Tree lungwort on a large, fissured hazel stem, Ballyarr Wood Nature Reserve, Co. Donegal.

deadwood in hazel woodland tends to be smaller in diameter compared to other woodland types. Retain moribund trees and if necessary, create additional deadwood.

- Ensure that the protection of features and indicators of local distinctiveness (e.g. rare species) is factored into management objectives.
- Windthrown trees should not be cut or removed unless they pose a safety risk or create access difficulties. If such trees are still rooted, existing branches will form new stems.
- Grazing may be important to maintain wood pasture and open spaces, but should not be so heavy that it damages the trees, field layer and ground flora. With careful control, a light seasonal grazing is most beneficial.
- Focus afforestation and conversion efforts on connecting existing stands, particularly if they are small or located along watercourses.
- Newly developing hazel scrub over limestone pavement may be overrunning other habitats of considerable value, and therefore may need to be controlled.
- Further management recommendations can be found in Coppins & Coppins (2012).

6. Yew Woodland

Overall description

Yew woods are very distinctive and rare and are confined to limestone outcrops in the southwest of the country. They are dominated by yew, with some ash and small amounts of rowan and oak (both pedunculate and sessile). Beech is often an associated species and while it is not native, it may in fact facilitate yew regeneration (Cross & Lynn, 2013b). Hazel is typically present in the shrub layer but is usually rather sparse, due to the heavy shade. Similarly, the herb layer is very poorly developed: ivy is the most common species present, with small amounts of false brome, carnation sedge and honeysuckle. In contrast, the moss layer is often luxuriant, although dominated by only a few species. The peeling bark of the yew trees means there are generally few epiphytes.

Characteristic features

- Dense canopy dominated by yew.
- Often large, old trees.
- Shrub and field layers are very poorly developed.
- Bryophyte layer is often well-developed but species-poor.
- Epiphyte flora is poorly developed due to the peeling nature of yew bark.
- Very little regeneration of any tree species.
- Small quantities of deadwood.
- Invasive non-native species usually represented by beech.

Yew woodland, Coole-Garryland Wood Nature Reserve, Co. Galway.

Management guidelines

- Maintain the yew canopy. Any felling should be restricted to non-native species.
- Native species should account for 80% or more of the canopy. A low cover of beech can be tolerated, as it may encourage yew regeneration. The retention of any exotic veteran trees present may be considered, due to their potential habitat value.
- Monitor and control the regeneration of non-native species. However, the total removal of beech may not be necessary.
- The canopy can be opened up by the removal of non-native species.
- Retain large old trees.
- Try to manage for a range of deadwood types and sizes, particularly by retaining veteran or moribund trees. However, deadwood should not be deliberately created from yew.
- Ensure that the protection of features and indicators of local distinctiveness (e.g. rare species, rock outcrops) is factored into management objectives.
- Focus on opportunities to expand yew woodland onto suitable adjacent areas. Young yew trees seem to grow best under a deciduous canopy. This includes beech, which actually appears to nurture regeneration (Cross & Lynn, 2013b).
- Windthrown trees should not be cut or removed unless they pose a safety risk or create access difficulties. If such trees are still rooted, existing branches will form new stems.
- Yew trees should not be felled or harvested for wood or timber, because of the rarity of this woodland type.
- Ensure that grazing pressure is managed in order to encourage the development of the shrub and herb layers and to stimulate regeneration in any available light gaps.

7. Willow Woodland

Overall description

Willow woodland falls into two distinct types: (i) woodlands of tall, mostly narrow-leaved willow species in which nettle is abundant (also referred to as 'gallery woodland'); and (ii) sally woodland.

Willow – nettle woodland (a subtype of alder – meadowsweet) is dominated by a mixture of the larger tree willows, i.e. almond-leaved willow, osier, white willow and crack-willow. The introduced sycamore, horse chestnut and beech are occasional in the canopy. Also see Section C8 Alluvial Woodland.

Willow – nettle woodland occurs predominantly on islands and banks of lowland rivers that are frequently inundated. It is particularly common in the lower reaches of rivers subject to tidal, although not saline, influence. The soils are mostly minerotrophic gleys, base-rich (pH *c.*7.2) and highly fertile, due to alluvial deposition. The field layer characteristically comprises a dense tangle of tall herbs that, together with fallen and uprooted trees and branches, makes access extremely difficult. Common species include nettle, hedge bindweed, canary reed-grass, water dropwort, angelica, meadowsweet, ivy, woody nightshade, valerian, yellow flag and goose-grass.

Some of the willows in this woodland type may be archaeophytes (i.e. non-native species established on this island before 1500 AD), although this is still a subject of debate amongst taxonomists. However, they are not invasive and the very open character of the canopy allows the strong growth of native herbs and shrubs. The stands play an important role in the dynamics of riverine systems and have important hydrological and ecological functions. Some stands represent former osier beds, and these have a historical and cultural importance as remnants of former industries. Some of these stands contain large old pollards that provide habitat for a variety of plant and animal species.

Willow woodland subject to regular tidal flooding, River Blackwater, Cappoquin, Co. Waterford.

Woody nightshade, a typical species of alluvial woodlands.

Sally woodlands are more widespread, occurring on waterlogged, often inundated land. The soils can be fen peats or gleyed mineral soils. The woodlands are dominated by sally, which typically forms stands of fallen, horizontal or often partially buried / flooded branches that produce numerous vertical stems to form a low canopy. Ash and alder are often present but provide little cover. The field layer is typically dominated by bramble, ivy, meadowsweet, sedges and grasses such as canary reed-grass. The bryophyte cover is typically low, but there may be well-developed lichens on individual stems. The combination of the wet ground and tangled structure makes these woodlands very difficult to access.

Characteristic features

- Canopy is comprised mainly of willows.
- Canopy is often open due to hydrology.
- Canopy sometimes contains old pollarded trees.
- Shrub and field layers are often well-developed.
- Bryophyte flora is poorly developed but there may be locally rich epiphytic flora, especially lichens.
- Rarely grazed due to the nature of the terrain.
- Often a tangle of fallen trees and branches, making access very difficult.
- Varying quantities of deadwood.
- Hydrology is an important controlling factor, but the woodlands themselves have a very important function in regulating water flow and runoff.
- Invasive non-native species include red-osier dogwood, sycamore and Himalayan balsam.

Management guidelines

- Native species and / or archaeophytes should account for 90% or more of the canopy.
- The stand structure is often naturally open due to the hydrology. In general, willow woodlands require little management, and there is seldom a need to thin or to remove non-natives from the understorey. Due to site conditions, access for management is often impractical.
- Maintain a diverse herb layer.
- Control invasive exotic species, particularly red-osier dogwood, Himalayan balsam and Japanese knotweed. Where best practice involves herbicide use, consult with Inland Fisheries Ireland and other relevant bodies in advance. Controlling such species is difficult and expensive, and often requires a wider catchment approach for progress to be sustained.
- Retain large old trees, especially pollards.
- Ensure a range of different types and sizes of deadwood. In particular, retain veteran and moribund trees and old pollards.
- Ensure that the protection of features and indicators of local distinctiveness (e.g. rare species, springs) is factored into management objectives.
- Focus afforestation and conversion efforts on connecting existing stands along watercourses. However, leave areas of fen, marsh, etc. undisturbed, as these will form natural clearings.
- Windthrown trees should not be cut or removed unless they pose a safety risk or create access difficulties. If such trees are still rooted, existing branches will form new stems.
- These woodlands are largely unsuitable for wood production, due to their location on sensitive soils subjected to a high watertable and frequent inundation. However, some have developed from former osier beds, and their restoration and harvesting for basket-making could be considered.

8. Alluvial Woodland

Overall description

Alluvial woodland is a generic term applied to the wetter elements of other woodland types, as detailed below. It is a category defined by hydrology (rather than by any distinct floral assemblage), as it is linked primarily to the occurrence of periodic flooding, mostly by flowing water that leaves a mineral deposit (or alluvium) behind when the waters recede. They occur principally adjacent to rivers and on lakeshores. Woodland fringing turloughs may also be considered as falling into this type. Flooding may occur frequently and at least annually, or infrequently at intervals of several years, but the inundation will nonetheless determine the vegetation. The duration of flooding can vary from a few hours (in the case of tidal flooding) to days, weeks or even months. Given the highly irregular rainfall patterns in Ireland, flooding can occur at any time of the year, although it is more common in the autumn and winter. Soils vary from fine alluvium and silt to sands and gravels. The pH is usually above 6.0 but may be lower in uplands valleys.

Alluvial woodland includes a variety of types, most of which are variants of alder or ash woodlands. They include the following:

- Narrow bands of alder, ash, sally and hazel alongside fast-flowing, upland streams / rivers running through sessile oak woodland. They are usually flooded for short periods following heavy rain, i.e. a few hours or days at the most and the soils are often well-drained. The herb layer contains species of more fertile soil, such as wood anemone, celandine, primrose, wild garlic, meadowsweet and water dropwort.
- Alder stands with ash and sally in depressions, such as old river channels, flooded for long periods. The soils are often poorly drained and may remain

Ballyseedy Wood, Co. Kerry, subject to periodic flooding. Characteristic bare patches occur where water ponds.

wet for long periods. Sometimes sally may dominate, forming a tangle of fallen stems. The herb layer is luxuriant with species such as meadowsweet, canary reed-grass, water mint, marsh bedstraw, yellow flag and valerian.

- Woodlands of ash, oak (mostly *Quercus robur*) and alder, with hazel, hawthorn and willows in the shrub layer, subject to periodic flooding of variable length on lowland rivers. The soils are well-drained to wet. There is typically an abundance of vernal species within the herb layer, e.g. wild garlic, bluebell and celandine, with sedges and meadowsweet dominating in summer.
- Gallery woodlands, comprising tall, narrow-leaved willows, occur alongside river channels and occasionally on river islands, where the tree roots are almost continuously submerged. The field layer is characteristically a dense tangle of nettle, canary reed-grass, water dropwort, angelica, meadowsweet and hedge bindweed. See Section C7 WILLOW WOODLAND.
- Woodlands of alder, ash and sally, sometimes with purging buckthorn around lakeshores subject to prolonged flooding, i.e. several weeks or even months, following a rise in lake level or ground water level. The soils may be poorly- to well-drained. The herb layer is species-rich with, e.g. purple loosestrife and tussock-forming sedges, e.g. *Carex elata*.
- Vegetation of turlough margins have a distinctive flora of low growing alder with hawthorn and purging buckthorn and meadowsweet in the field layer.
- Alder, ash and willow woodlands around flushes or springs. The soils are poorly drained and remain wet throughout the year. The field layer includes remote sedge, creeping buttercup, opposite-leaved saxifrage and wood avens. Locally there may be stands of tussock sedge.

The innate fertility of alluvial soils means that many alluvial woodlands have been cleared for agriculture, even if the land is periodically flooded. Drainage has changed the hydrology in many places, leading to woodlands drying out. Many stands are small and fragmented, particularly on deeper soils. These woodlands have rarely been systematically managed for wood production, although larger trees may have been selectively removed. Many are low-growing and often scrubby, with a tangle of fallen trees and deadwood. Nonetheless, they have the potential for wood production, particularly on drier sites. However, their greatest value is in the role they play in ecosystem services, i.e. regulating river flow, filtering groundwater and surface run-off, providing corridors for the movement of biodiversity across the landscape, and their influence on aquatic – particularly riverine – ecosystems.

Further details on the character and management of alluvial woodlands can be found in the Woodlands of Ireland Information Note 4 (*Native riparian woodlands: A guide to identification, design, establishment and management*) (Little *et al.*, 2017).

Characteristic features

- Variable in structure and species composition, depending on location and soil type. Flooding is a determining element of the ecosystem.
- Few large, old trees.
- Shrub layer is often rich with some uncommon species.

- Field layer is species-rich. Bryophyte and lichen flora may be well-developed.
- Rarely subjected to grazing.
- Often abundant deadwood.
- Invasive species include sycamore, red-osier dogwood, Himalayan balsam and giant hogweed.

Management guidelines

- The overriding factor is the wet substrate, which dictates the timing and selection of management options.
- Maintain a minimum canopy cover of 70%. Stand structure may be naturally open due to hydrology, particularly alongside channels.
- Native species should comprise 90% or more of the canopy. The retention of any non-native veteran trees present may be considered, due to their potential habitat value. However, it may be necessary to control associated regeneration.
- Control invasive exotic species, particularly red-osier dogwood and Himalayan balsam. Where best practice involves herbicide use, consult with Inland Fisheries Ireland and other relevant bodies in advance. Controlling such species is difficult and expensive, and often requires a wider catchment approach for progress to be sustained.
- Ensure a range of different types and sizes of deadwood. In particular, retain veteran and moribund trees and if necessary, create additional deadwood.
- If the felling of any large old tree is being considered, undertake a careful assessment to ascertain whether or not it supports any important population of epiphytes, invertebrates, bats, etc.
- Ensure that the protection of features and indicators of local distinctiveness (e.g. rare species, springs) is factored into management objectives.
- Focus afforestation or conversion effort on connecting existing stands and on sites sensitive to bank erosion. However, leave patches of fen, marsh, well-established marginal vegetation, etc. undisturbed, to form natural clearings.
- Windthrown trees should not be cut or removed unless they pose a safety risk or create access difficulties. If such trees are still rooted, existing branches will form new stems.
- Where the land is not too wet, there is the potential for wood production, using appropriate CCF. However, in general, a setback of at least 15 metres should be maintained along the watercourse, within which felling is excluded.
- Where appropriate and possible, restore traditional silvicultural management practices over small areas, e.g. managing willows for basket making, coppicing.
- Ensure that grazing pressure is managed in order to allow the development of a well-structured wood.
- Anglers can be facilitated by creating a bank-side path and / or by introducing gaps in the canopy and understorey alongside the river channel, to allow for overhead casting.

Part D
APPENDICES

Appendix 1: Species List

The following list (continued overleaf) sets out the common names and Latin names of plants mentioned in the text, after Preston *et al.* (2002).

Alder *Alnus glutinosa*

Alder buckthorn *Frangula alnus*

Almond-leaved willow *Salix triandra*

Angelica *Angelica sylvestris*

Ash *Fraxinus excelsior*

Aspen *Populus tremula*

Barren strawberry *Potentilla sterilis*

Beech *Fagus sylvatica*

Bilberry *Vaccinium myrtillus*

Birch species *Betula* spp.

Bird cherry *Prunus padus*

Blackthorn *Prunus spinosa*

Bluebell *Hyacinthoides non-scripta*

Bracken *Pteridium aquilinum*

Bramble *Rubus fruticosus* agg.

Broad buckler-fern *Dryopteris dilatata*

Canary reed-grass *Phalaris arundinacea*

Carnation sedge *Carex panicea*

Celandine *Ranunculus ficaria*

Cherry laurel *Prunus laurocerasus*

Columbine *Aquilegia vulgaris*

Common polypody *Polypodium vulgare*

Crab apple *Malus sylvestris*

Crack-willow *Salix fragilis*

Creeping buttercup *Ranunculus repens*

Dandelion *Taraxacum officinale*

Douglas fir *Pseudotsuga menziesii*

Downy birch *Betula pubescens*

Early purple orchid *Orchis mascula*

Eucalyptus species *Eucalyptus* spp.

False brome *Brachypodium sylvaticum*

Gaultheria species *Gaultheria* spp.

Giant hogweed *Heracleum mantegazzianum*

Goose-grass *Galium aparine*

Guelder-rose *Viburnum opulus*

Hard fern *Blechnum spicant*

Hawthorn *Crataegus monogyna*

Hazel *Corylus avellana*

Hedge bindweed *Calystegia sepium*

Himalayan balsam *Impatiens glandulifera*

Himalayan honeysuckle *Leycesteria formosa*

Himalayan knotweed *Polygonum polystachum*

Holly *Ilex aquifolium*

Honeysuckle *Lonicera periclymenum*

Horse chestnut *Aesculus hippocastanum*

Hybrid oak *Quercus* x *rosacea*

Irish spurge *Euphorbia hyberna*

Irish whitebeam *Sorbus hibernica*

Ivy *Hedera helix*

Japanese knotweed *Fallopia japonica*

Kidney saxifrage *Saxifraga hirsuta*

Killarney fern *Trichomanes speciosum*

Larch species *Larix* spp.

Lime species *Tilia* spp.

Ling heather *Calluna vulgaris*

Lodgepole pine *Pinus contorta*

Marsh bedstraw *Galium palustre*

Meadowsweet *Filipendula ulmaria*

Montbretia *Crocosmia* x *crocosmiiflora*

Nettle *Urtica dioica*

Norway spruce *Picea abies*

Opposite-leaved saxifrage *Chrysosplenium oppositifolia*

Orange-barked myrtle *Myrtus luma*

Osier *Salix viminalis*

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Pedunculate oak *Quercus robur*
Primrose *Primula vulgaris*
Purging buckthorn *Rhamnus catharticus*
Purple loosestrife *Lythrum salicaria*
Purple moor-grass *Molinia caerulea*
Red-osier dogwood *Cornus sericea*
Remote sedge *Carex remota*
Rhododendron *Rhododendron ponticum*
Rowan *Sorbus aucuparia*
Sally *Salix cinerea*
Scots pine *Pinus sylvestris*
Sedge species *Carex* spp.
Sessile oak *Quercus petraea*
Shallon *Gaultheria shallon*
Silver birch *Betula pendula*
Silver fir *Abies alba*
Sitka spruce *Picea sitchensis*
Snowberry *Symphoricarpos albus*
Spindle *Euonymus europaeus*
Stitchwort *Stellaria holostea*
Strawberry tree *Arbutus unedo*
Sweet chestnut *Castanea sativa*
Sweet woodruff *Galium odoratum*
Sycamore *Acer pseudoplatanus*
Toothwort *Lathraea squamaria*
Tufted sedge *Carex elata*
Tussock sedge *Carex paniculata*
Tutsan *Hypericum androsaemum*
Valerian *Valeriana officinalis*
Violet species *Viola* spp.
Water dropwort *Oenanthe crocata*
Water mint *Mentha aquatica*
Western hemlock *Tsuga heterophylla*
White willow *Salix alba*
Whitebeam *Sorbus* spp.
Wild cherry *Prunus avium*
Wild garlic *Allium ursinum*
Willow species *Salix* spp.
Wood anemone *Anemone nemorosa*
Wood avens *Geum urbanum*
Woodrush *Luzula sylvatica*
Wood sorrel *Oxalis acetosella*
Woody nightshade *Solanum dulcamara*
Yellow flag *Iris pseudacorus*
Yew *Taxus baccata*

Appendix 2: Native Woodland Classification Systems

Introduction

A number of different classification systems for native Irish woodlands have been used over the years, from relatively straightforward 'practical' systems (e.g. Fossitt, 2000) to more complex 'academic' systems (e.g. Kelly, 1981). The classification used in these *Management Guidelines for Ireland's Native Woodlands*, as elaborated in this appendix, is based (with some amendments) on the principal types identified in the National Survey of Native Woodlands 2003-2008 (Perrin *et al.*, 2008), in which the dominant canopy tree defines the name. These types include numerous subtypes, although in general these are unimportant in terms of management practices.

The table set out in the following pages presents various classification systems, as follows:

- The first and second columns set out the native woodland classification system described above, based on the NSNW. Subtypes highlighted by **red coloured font** in the second column are relatively rare in Ireland and occur sometimes in a complex or mosaic with other subtypes.
- The third column sets out the classification system used under the previous version of the Forest Service Native Woodland Scheme (NWS), as described in contemporary scheme documentation (see DAFM, 2005). **Note:** For the purpose of the scheme, this system was replaced in September 2015 by that set out in the first and second columns of the table presented overleaf. See DAFM (2015a & 2015b) for further details.
- The fourth column sets out the corresponding habitats under the classification system described in Fossitt's *A guide to habitats in Ireland* (2000).
- The fifth column lists the corresponding natural habitats under Annex I of the Habitats Directive (with the asterisk symbol '*' indicating priority habitats).
- The sixth column sets out the corresponding phytosociological categories.

The table overleaf is reproduced (with minor amendments) from the Woodlands of Ireland Information Note 6 (*The classification of native woodlands in Ireland and its application to native woodland management*) (Cross *et al.*, 2010). Please note that the table gives the closest affinities between the different classification systems. In some cases, the fit is close; in other cases, it is tenuous or uncertain.

Note (from p.127): The non-native species of beech, sycamore and laurel are widespread in ash woodlands, sometimes as significant components. Their inclusion in the classification system helps in the identification of the woodland type only and does not indicate that they should be considered desirable species or that they should be retained or planted. On the contrary, management should aim to convert these stands toward the relevant ash woodland type, removing the non-native species in the process.

National Survey of Native Woodlands (as amended)		Former NWS (DAFM, 2005)	Fossitt (2000)	Habitats Directive Annex I (with code)	Phyto-sociological categories
Type	**Subtype**				
Quercus – Luzula **(Sessile oak – woodrush) QL**	***Vaccinium – Ilex*** **(Bilberry – holly) QL1**	**A1** Species-poor [sessile] oak woodland on drier sites **A2** Moss- and lichen-rich [sessile] oak woodland	**WN1** Oak-birch-holly woodland	Old oak woods with holly & hard fern (91A0)	*Blechno – Quercetum scapanietosum / typicum*
	Luzula – Dryopteris **(Woodrush – broad buckler-fern) QL2**	**A1** Species-poor [sessile] oak woodland on drier sites **A2** Moss- and lichen-rich [sessile] oak woodland	**WN1** Oak-birch-holly woodland	Old oak woods with holly & hard fern (91A0)	*Blechno – Quercetum scapanietosum / typicum*
	Rubus – Corylus **(Bramble – hazel) QL3**	**A3** [Sessile] oak woodland with hazel & ash	**WN1** Oak-birch-holly woodland **WN2** Oak-ash-hazel woodland **WD2** Mixed broadleaved / conifer woodland	Old oak woods with holly & hard fern (91A0)	*Blechno – Quercetum coryletosum*

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Fraxinus – Hedera **(Ash – ivy)** **(FH)**	***Geum – Veronica*** **(Wood avens – wood speedwell)** **(FH1)**	**B1** [Pedunculate] oak-ash-hazel woodland on relatively deep soils	**WN2** Oak-ash-hazel woodland **WD1** (Mixed) broadleaved woodland	Residual alluvial forests (91E0)*	*Corylo – Fraxinetum veronicetosum*
	Quercus – Rubus **(Pedunculate oak – bramble)** **(FH2)**	**B1** [Pedunculate] oak-ash-hazel woodland on relatively deep soils **A3** [Sessile] oak woodland with hazel and ash	**WN1** Oak-birch-holly woodland **WN2** Oak-ash-hazel woodland	No equivalent	*Corylo – Fraxinetum typicum*
	Corylus – Oxalis **(Hazel – wood sorrel)** **(FH3)**	**B2** [Pedunculate] oak-ash-hazel woodland on shallow, often rocky, soils over limestone **G2** Hazel scrub on limestone pavement	**WN2** Oak-ash-hazel woodland	Limestone pavements (8240)* (scrubby facies)	*Corylo – Fraxinetum veronicetosum / neckeretosum*
	Ilex – Sorbus **(Holly – rowan)** **(FH4)**	**A1** Species-poor [sessile] oak woodland on drier sites **B1** [Pedunculate] oak-ash-hazel woodland on relatively deep soils	**WN1** Oak-birch-holly woodland **WN2** Oak-ash-hazel woodland	No equivalent	*Blechno – Quercetum typicum / coryletosum*
	Fagus – Prunus **(Beech – cherry laurel)** **(FH5)** (see Note p.125)	**B1** [Pedunculate] oak-ash-hazel woodland on relatively deep soils	**WD1** (Mixed) broadleaved woodland **WN2** Oak-ash-hazel woodland	No equivalent	Not described
	Acer – Crataegus **(Sycamore – hawthorn)** **(FH6)** (see Note p.125)	**B1** [Pedunculate] oak-ash-hazel woodland on relatively deep soils	**WD1** (Mixed) broadleaved woodland **WN2** Oak-ash-hazel woodland	No equivalent	*Corylo – Fraxinetum typicum*
	Taxus – Carex **(Yew – carnation sedge)** **(TC)**	**B3** Yew woodland	**WN3** Yew woodland	Yew woods (91J0)*	*Corylo – Fraxinetum neckeretosum*

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Alnus – Filipendula **(Alder – meadow-sweet)** **(AF)**	***Fraxinus – Carex remota*** **(Ash – remote sedge)** **(AF1)**	**E3** Ash-alder-remote sedge woodland **C1** Wet pedunculate oak-ash woodland rich in species	**WN6** Wet willow-alder-ash woodland **WN4** Wet pedunculate oak-ash woodland	Residual alluvial forests (91E0)*	*Carici remotae – Fraxinetum / Corylo – Fraxinetum deschampsietosum*
	Alnus – Rubus **(Alder – bramble)** **(AF2)**	**C2** Woodland of floodplains subject to intermittent flooding **C1** Wet pedunculate oak-ash woodland rich in species	**WN6** Wet willow-alder-ash woodland	Residual alluvial forests (91E0)*	*Osmundo – Salicetum / Alnus glutinosa – Carex paniculata* unit
	Salix – Equisetum **(Grey willow – water horsetail)** **(AF3)**	**E1** Willow-alder carr on fen peat **C2** Woodland of floodplains subject to intermittent flooding	**WN6** Wet willow-alder-ash woodland	Residual alluvial forests (91E0)*	*Osmundo – Salicetum*
	Crataegus – Geranium **(Hawthorn – Herb Robert)** **(AF4)**	**C2** Woodland of floodplains subject to intermittent flooding	**WN2** Oak-ash-hazel woodland **WN6** Wet willow-alder-ash woodland	Residual alluvial forests (91E0)* / Turloughs (3180)*	*Corylo – Fraxinetum veronicetosum*
	Betula – Mentha **(Birch – water mint)** **(AF5)**	**C2** Woodland of floodplains subject to intermittent flooding	**WN6** Wet willow-alder-ash woodland	Residual alluvial forests (91E0)*	*Osmundo – Salicetum*
	Alnus – Carex paniculata **(Alder – tussock-sedge)** **(AF6)**	**E2** Alder carr with tussock sedge	**WN6** Wet willow-alder-ash woodland	Residual alluvial forests (91E0)*	*Alnus glutinosa – Carex paniculata* unit
	Alnus – Equisetum **(Alder – giant horsetail)** **(AF7)**	None	**FP1** Calcareous springs	Petrifying springs with tufa formation (7220)*	*Equiseto telmatejae – Fraxinetum* association
	Salix – Urtica **(Almond willow – nettle)** **(SU)**	**D** Willow woodland alongside river channels (gallery or riparian woodland)	**WN5** Riparian woodland **WD1** (Mixed) broadleaved woodland	Residual alluvial forests (91E0)*	*Salicetum albae*

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Betula – Molinia **(Birch – purple moor-grass)** **(BM)**	***Rubus – Dryopteris*** **(Bramble – broad buckler-fern)** **(BM1)**	**F1** Dry birch woodland	**WN7** Bog woodland	No equivalent	*Vaccinio uliginosi – Betuletum*
	Vaccinium – Luzula **(Bilberry – woodrush)** **(BM2)**	**F1** Dry birch woodland **A1** Species-poor [sessile] oak woodland on drier sites	**WN1** [Sessile] oak-birch-holly woodland **WN7** Bog woodland	Old oak woods with holly & hard fern (91A0)	*Vaccinio uliginosi – Betuletum / Blechno-Quercetum*
	Holcus – Agrostis **(Yorkshire fog – bent grass)** **(BM3)**	**F1** Dry birch woodland **A1** Species-poor [sessile] oak woodland on drier sites	**WN7** Bog woodland **WN1** [Sessile] oak-birch-holly woodland	No equivalent	Not described
	Hedera – Fraxinus **(Ivy – ash)** **(BM4)**	**F1** Dry birch woodland **A1** Species-poor [sessile] oak woodland on drier sites	**WN7** Bog woodland **WN2** Oak-ash-hazel woodland	No equivalent	*Corylo – Fraxinetum*
	Salix – Galium **(Grey willow – marsh bedstraw)** **(BM5)**	None	**WN7** Bog woodland **WN6** Wet willow-alder-ash woodland	Residual alluvial forests (91E0)*	*Osmundo – Salicetum / Sphagnum palustre – Betula pubescens* unit
	Molinia – Potentilla **(Grey willow – grass-tormentil)** **(BM6)**	**F2** Wet birch woodland with sphagnum	**WN7** Bog woodland	Bog woodland (91D0)*	*Sphagnum palustre – Betula pubescens* unit */ Salicetum auritae*
Low woodland **(LW)**	***Prunus spinosa*** **(Blackthorn scrub)** **(LW1)**	**L** Blackthorn scrub	**WS1** Scrub	No equivalent	*Corylo – Fraxinetum*
	Corylus avellana **(Hazel scrub)** **(LW2)**	**G** Hazel scrub	**WS1** Scrub	No equivalent	*Corylo – Fraxinetum*
	Juniperus communis **(Juniper scrub)** **(LW3)**	**K** Juniper scrub	**WS1** Scrub	Juniper formations on heaths or calcareous grasslands (5130)	Various

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Appendix 4: Glossary

Afforestation The creation of new woodland or forest on open land. Defined under the Forestry Act 2014 as the conversion of land to a forest.

Age class structure The distribution of defined age categories of trees within a stand. The long term sustainability of that stand will often depend on achieving and maintaining a certain distribution of age classes within it, to ensure the ongoing recruitment of younger trees into the canopy.

Agro-forestry A land use that combines the growing of trees with conventional farming practices. Trees can be planted at wide spacings either singly, in groups or in rows. Where grazing is intended, tree shelters (1.5 m or taller) are used.

Ancient tree See Veteran tree.

Ancient woodland An area assessed as having been under woodland cover since 1660, based on the oldest reliable national records such as estate records and the Down and Civil Surveys.

Annex I habitat A natural habitat listed under the Habitats Directive as being of EU Community interest and whose conservation requires the designation of Special Areas of Conservation. Member States are legally obliged to protect Annex I habitats.

Aquatic buffer zone (ABZ) An area at least 10 metres in width and created alongside a stream, river or lake, within which forestry operations are limited in order to protect water from direct disturbance and the runoff of sediment and nutrients. Within the context of afforestation, the ABZ remains generally undisturbed to allow a protective strip of natural ground vegetation to emerge. The creation of appropriate ABZs is a general requirement attached to licences / approvals issued by the Forest Service for regulated forestry activities. For details in relation to afforestation (in which context, the ABZ is referred to as the 'water setback'), see the Forest Service *Environmental Requirements for Afforestation* (DAFM, 2016).

Aquatic zone A permanent or seasonal river, stream or lake shown on an Ordnance Survey 6 inch map.

Beating up See Filling-in.

Biodiversity The variety of living organisms, including: the diversity of species; the genetic diversity or variation within the species; and the ecosystems in which the species occur.

Birds Directive Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds.

Brash mat A layer of cut branches set down during harvesting and extraction operations in order to prevent or reduce soil damage by forest machinery.

Bryophyte A division of the plant kingdom that contains small, rootless, non-vascular plants such as mosses and liverworts.

Cabling A method of timber extraction whereby felled tree lengths are removed from the site through the use of cables attached to anchor trees. Although specialised and expensive, cabling may be an option on steep slopes or sensitive sites, where extraction by wheeled or tracked machine is deemed to be impractical or unsuitable.

Canopy The combined crowns of individual trees within a woodland or forest. The composition and condition of the canopy provides foresters with vital information about the overall health and development of the woodland.

Carbon sequestration The process by which carbon dioxide is removed from the atmosphere and stored as carbon in plant tissue (including wood), soil litter and deadwood.

Catchment The area from which a stream, river or lake derives its water.

Clearfell A form of harvesting whereby the entire stand (typically even-aged) is felled in a single operation. Clearfelling is the most common form of harvesting within Ireland's commercial forest sector.

Climax vegetation The vegetation that theoretically would exist in any given place, as determined by the climate and soils and without the impact of human activity.

Close-to-nature silviculture An approach to forest management which mimics natural processes such as windthrow and fire, and which utilises natural processes such as natural regeneration, in order to influence age and species diversity within a woodland or forest.

Coillte Old Woodland Survey A desk-based survey undertaken by Coillte in 2001, which involved tracing the history of woodland cover on all of its properties by consulting the 1st and 3rd Edition Ordnance Survey map series. The survey found that *c.*27,000 ha constituted old woodland sites (also referred to as 'long-established woodland').

Conservation status (habitat) An assessment of the health of a natural habitat, based on the sum of the influences acting on that habitat and its typical species that may affect its long term natural distribution, structure and functions as well as the long term survival of its typical species. Methods for assessing conservation status were drawn up by the European Topic Centre for Nature Conservation in conjunction with the Scientific Group of the Habitats Directive. It involves the application of a 'favourable', 'inadequate', 'bad' or 'unknown' assessment to four separate parameters (i.e. range, area, structures and functions, and future prospects) and an assessment of overall status (NPWS, 2013).

Continuous cover forestry (CCF) A type of low-impact silviculture that involves the use of selective harvesting and natural regeneration to promote uneven-aged stands and a continuous tree cover more typical of natural forests. CCF systems most relevant to native woodland management are selection, shelterwood and coppice. CCF is generally regarded as close-to-nature silviculture.

Conversion The process of changing a non-native forest to native woodland. Conversion can be carried out through *via* gradual transformation or more abrupt replacement.

Coppice A tree cut just above ground level and allowed to produce new shoots, which are subsequently also cut. Defined under the Forestry Act 2014 as a forest crop raised from shoots produced from the cut stumps of the previous crop.

Coppicing A CCF system in which trees are cut just above ground level to encourage the production of multiple stems. These stems are then grown on and subsequently harvested after a number of years (depending on the diameter required for a particular end-use), thereby initiating a repeat of the cycle. Coppicing is an ancient form of woodland management in Ireland.

Coupe A small-scale opening within an existing canopy, created to facilitate woodland rejuvenation through natural regeneration and / or planting. In the context of commercial plantations, the term also applies to an area of clearfell.

Crown The foliage-bearing part of a tree, including the branches, foliage and upper stem.

Deadwood Dead stems, branches and other woody debris standing or lying on the forest floor. As the deadwood breaks down and decays, it provides a range of valuable habitats for a wide variety of organisms.

Deciduous A term used to describe species of trees that shed their leaves annually in autumn and replace them the following spring. In Ireland, examples include broadleaves such as sessile oak, silver birch and common beech, and some conifers, such as European larch.

Dormant season The period of the year during which the physiological processes within the tree are at their lowest ebb. Trees should ideally be planted during their dormant season, to minimise planting shock.

Ecosystem A dynamic, interacting community of interdependent organisms (plants, animals, fungi, bacteria, etc.) together with the physical environment which they inhabit and upon which they depend.

Ecosystem services Benefits provided by ecosystems that contribute to making human life both possible and worth living. These include: provisioning services such as food and water; regulating services such as the maintenance of water quality, flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth. The services and goods that an ecosystem provides are often undervalued, as many of them are without market value.

Emmergent A tree that grows above the main canopy, usually singly and widely-spaced.

Environmental guidelines Operational guidelines compiled by the Forest Service and setting out measures that are mandatory for all regulated (and grant-aided, where relevant) forestry activities, in order to protect various environmental features and sensitivities, e.g. landscape, water, archaeology, biodiversity. Mandatory measures applying to afforestation are set out in the document *Environmental Requirements for Afforestation* (DAFM, 2016).

Establishment The point at which a young tree is free-growing, i.e. above the height of competing vegetation. Within the context of early woodland development, it refers to the point at which an adequate number of trees of the desired species are free-growing.

European Communities (Birds & Natural Habitats) Regulations 2011 (S.I.477 of 2011) The principal instrument transposing the Birds and Habitats Directives into Irish law, with provisions for (*inter alia*): the conservation of natural habitats and habitats of species; activities, plans or projects affecting European sites; appropriate assessment; and the protection of flora and fauna.

Evergreen A term used to describe species of trees that retain their leaves through the year, shedding and replacing them over a several year cycle. In Ireland, examples include conifers such as Norway spruce, Scots pine and yew, and some broadleaves, such as holly and Holm oak.

Favourable conservation status (habitat) The conservation status of a natural habitat will be taken as favourable when: its natural range and areas it covers within that range are stable or increasing; and the specific structure and functions which are necessary for its long term maintenance exist and are likely to continue to exist for the foreseeable future; and the conservation status of its typical species is favourable (NPWS, 2013).

Felling licence A licence permitting the felling of trees, issued by the Minister of Agriculture, Food & the Marine under the Forestry Act 2014, as set out under Forestry Regulations 2017 (S.I.191 of 2017). Applications for Felling Licences are assessed by the Forest Service.

Fell-to-recycle See Fell-to-waste.

Fell-to-waste A management option on a thinning or clearfell site, whereby felled trees are not extracted off site, but are instead left onsite, typically *in situ* where felled. This practice foregoes the value of recoverable wood but eliminates the extraction operation, and is therefore a suitable option on sites deemed highly sensitive, due to existing habitats and species, sensitive soils or steep slope. Also referred to as 'fell-to-recycle', as the entire tree remains onsite as deadwood, with nutrients returned to the soil naturally through decay.

Fertiliser A substance used to enrich the soil with particular nutrients, to boost tree establishment and early growth. Slow release formulations should be favoured, applied manually into the planting pit or around the base of the newly planted tree.

Filling-in A silvicultural operation involving the planting of new trees within an establishing woodland, to replace dead trees and to fill vacant planting positions, and thereby to aid establishment. The operation is normally carried out in the second or third year after initial planting, to ensure that stocking levels are maintained and to avoid gaps in the emerging canopy. Also referred to as 'beating up'.

Floodplain Land adjacent to a stream, river or lake that experiences flooding during periods of high discharge.

Forest Defined under the Forestry Act 2014 as land under trees with a minimum area of 0.1 ha and tree crown cover of more than 20% of the total area (or the potential to achieve this cover at maturity), and includes all species of trees.

Forest land A collective term applied to planted and natural forests, as well as temporarily unstocked areas (e.g. recent clearfell sites) and permanently unstocked areas within forest boundaries.

Forest reproductive material A collective term used to describe seeds, plants and

other propagating material important for forestry purposes, particularly of those species specified in the Forest Reproductive Material Directive (Council Directive 1999/105/EC). Defined under the Forestry Act 2014 as the reproductive material of tree species and artificial hybrids that are important for forestry purposes.

Forest Reproductive Material Directive EU Council Directive 1999/105/EC on the marketing of forest reproductive material. It stipulates that forest reproductive material may not be marketed unless it is from one of four specified categories, and that only approved basic material (the trees from which reproductive material is harvested) may be used for its production. The Directive requires the registration of seed collectors and nursery growers, and the development of a chain of custody, from seed collection right through to the eventual planting site.

Forest Service Ireland's national forest authority, responsible for forest policy, the promotion of the forest sector, the administration of forestry grant schemes, felling control, forest protection, and the National Forest Inventory. Part of the Department of Agriculture, Food & the Marine (DAFM) (www.agriculture.gov.ie/forestservice).

Forestry Act 2014 An Act to make further and better provision in relation to forestry, to provide for the development and promotion of forestry in a manner that maximises the economic, environmental and social value of forests within the principles of sustainable forest management, to confer power on the Minister for Agriculture, Food & the Marine to make regulations for the effective management of the forestry sector, to make further provision for the giving effect to acts of the institutions of the European Union by regulation made by that Minister in respect of forestry and forestry-related activities, to repeal the Forestry Act 1946, to amend the Wildlife Act 1976, to amend the Agriculture Appeals Act 2001, to amend the Environment (Miscellaneous Provisions) Act 2011 and to provide for related matters. Forestry Regulations 2017 (S.I.191 of 2017) apply.

Forestry Standards Manual Forest Service publication detailing the operational and administrative procedures and the silvicultural and environmental standards that apply under various forestry grant schemes. The *Forestry Standards Manual* also sets out the environmental referral protocol and the Forest Service Appropriate Assessment Procedure.

Formative pruning See Shaping.

Gallery woodland A type of alluvial woodland comprising tall willows alongside river channels, and occasionally on river islands, where the tree roots are almost continuously submerged.

Geographical Information System (GIS) A multi-layered computer-based system that enables the efficient inputting, storage, analysis and retrieval of geographic and land attribute data.

Global Positioning System (GPS) A satellite-based system used to determine the latitude and longitude of a receiver device on or near the earth's surface.

Habitat The physical and biotic environment in which an organism or community of organisms lives.

Habitats Directive The Council Directive 92/43/EEC of 21 May 1992 on the

conservation of natural habitats and of wild fauna and flora, which aims to promote the maintenance of biodiversity in Europe, taking account of economic, social, cultural and regional requirements. The EU Habitats Directive, together with the Birds Directive, forms the cornerstone of Europe's nature conservation policy, and establishes the EU-wide Natura 2000 ecological network of protected areas. Annex I and Annex II list natural habitats and species (both animal and plant) of community interest whose conservation requires the designation of Special Areas of Conservation by Member States. The Habitats Directive is transposed into Irish law under the European Communities (Birds & Natural Habitats) Regulations 2011 (S.I.477 of 2011).

Herbicide A chemical formulated to cause plant death. A range of formulations are available, with different modes of action. Their typical use within a woodland context is to manage competing vegetation around the base of young trees, to aid establishment.

Indigenous species See Native species.

Invasive species A species capable of rapid spread and which has a deleterious impact on other species and habitats. Although a few native species may be considered as invasive, the term is more typically applied to non-native species that are injurious to native species. Within a woodland context, invasive plants such as rhododendron and cherry laurel can suppress natural ground flora and the natural regeneration of woodland trees. Invasive animals include most species of deer (except red deer), which can cause considerable damage by overgrazing and stripping bark from trees.

Invert mounding A form of cultivation used to prepare a site for afforestation, whereby the soil is excavated, inverted and replaced back into its original location, into which the tree is then planted. Inverted mounding involves minimal site disturbance and creates a vegetation-free planting position, thereby reducing competition during the first growing season. This form of cultivation is best suited to mineral soils (as opposed to peat), as the mound disintegrates back into the pit.

Irish Deer Management Forum A forum established in 2015 to implement a series of actions on deer management and conservation set out in the document *Deer management in Ireland: A framework for action*, compiled following widespread consultation. The Forum itself comprises representatives from the main stakeholder areas such as landowners, forestry, hunting and conservation organisations, as well as representatives from the Department of Agriculture, Food & the Marine and the Department of Arts, Heritage, Regional, Rural & Gaeltacht Affairs.

Light demanding species Species that require high levels of light to survive. This is particularly important during the early years of growth, as species that are light demanding at seedling stage will die off if adequate light is not available.

Long-established woodland An area that has remained continuously wooded since at least the 1st Edition OS maps of the 1830s and 1840s, but for which there is no positive evidence that it had been wooded for longer, or for which there is evidence that the woodland is not ancient. Also referred to as 'old woodland'.

Mast year A year during which a tree produces a much higher than average quantity of seed in response to various natural cues.

Micro-climate The climatic conditions (temperature, humidity, light levels, etc.) within the immediate vicinity of a tree or within an area of woodland.

Minimal intervention area An identified area within a woodland where the native canopy is allowed to develop naturally into old growth forest and where the trees are allowed to complete their entire life cycle. Minimal intervention areas may still need management input to control unnatural threats to the woodland, e.g. invasive rhododendron. Also referred to as 'refuge area.'

Mulch Material added around the base of newly planted trees, to suppress competing ground vegetation and to promote establishment. Mulching may provide an alternative to the application of herbicides for managing vegetation on sensitive sites that are small in scale. A wide variety of organic and inorganic mulches are available.

National Forest Inventory (NFI) A statistical and multi-resource inventory carried out on a cyclical basis on the national forest estate by the Forest Service, in order to record and assess the extent and nature of Ireland's forests, both public and private, in a timely, accurate and reproducible manner. The NFI, undertaken initially in 2006 and again in 2009-12, is repeated in order to assess changes in the forest estate over time, to conform with national and international reporting requirements. Parameters recorded include: area and species composition, growing stock (m^3), biodiversity, health and vitality, carbon content and soil type, and data on minor tree species and natural regeneration. The 2nd NFI also recorded forest area change, volume increment and the latest harvesting volume estimates, thereby allowing the monitoring of aspects of sustainable forest management.

National Park An area of land protected for its outstanding scientific (biological, geological, geomorphological) and landscape importance and for its recreational, educational and scientific use, and recognised as such by the International Union for the Conservation of Nature (IUCN). All of Ireland's National Parks fall into the IUCN Category 2 and are owned by the State. Category 2 areas are typically large and conserve a functioning ecosystem, although to be able to achieve this, the protected area may need to be complemented by sympathetic management in surrounding areas.

National Parks & Wildlife Service (NPWS) The national body charged with the conservation of habitats and species in Ireland. Currently part of the Department of Arts, Heritage, Regional, Rural & Gaeltacht Affairs (see www.npws.ie), but it has been attached to various Government departments over the years.

National Survey of Native Woodlands A national survey of native woodlands undertaken between 2003 and 2008. The survey recorded (*inter alia*) plant species and information on area, location, soils, topography, invasive species, deadwood, grazing and natural regeneration. The data generated were used to produce a new and more comprehensive woodland vegetation classification system. For details, see Perrin *et al.* (2008).

Native species Species of plants and animals that arrived onto the island of Ireland naturally since the end of the last Ice Age. They are of particular biodiversity value,

having existed alongside other native flora and fauna over thousands of years. Also referred to as 'indigenous species'.

Native woodland Woodland dominated by native species of trees and other native plants.

Native Woodland Scheme A support package available under the Forestry Programme 2014-2020 to encourage the appropriate restoration and expansion of native woodlands in Ireland. The package comprises two separate 'elements': the Native Woodland Conservation Scheme and the Native Woodland Establishment Scheme (the latter represented by Grant & Premium Categories 9 and 10 under the general Afforestation Scheme). The package, originally launched in 2001, is implemented by the Forest Service in partnership with Woodlands of Ireland, the National Parks & Wildlife Service, the Heritage Council, Inland Fisheries Ireland and other native woodland stakeholders.

Natura 2000 site An encompassing term that applies to Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). The Natura 2000 Network comprises nature protection areas in the territory of the European Union, established to protect Europe's most valuable and threatened species and habitats, as listed under both the Birds Directive and the Habitats Directive.

Natural Heritage Area (NHA) An area considered important for the habitats present or which holds species of plants and animals whose habitat needs protection. NHAs are legally protected from damage under the Wildlife Amendment Act (2000). Currently, fully-designated NHAs encompass a number of raised and blanket bogs. Sites containing other habitats have been identified as proposed NHAs (pNHAs), but this is a non-statutory designation. In addition, the Geological Survey of Ireland (GSI) is compiling a list of geological / geomorphological sites in need of protection through NHA designation.

Natural regeneration The establishment of new trees and shrubs, and woodland, from seed arriving naturally (by animals, wind, water, etc.) onto the site from overhead sources within the woodland or from outside sources (typically adjoining or nearby, and occasionally distant). Defined under the Forestry Act 2014 as the generation of trees from natural seed fall.

Natural woodland Woodland dominated by native tree species and which has developed without human assistance or interference. It is generally held that little, if any, woodland in Ireland is entirely natural, as almost all woodland has been influenced by human activity. The term 'semi-natural woodland' is more often used.

Nature Reserve An area of high biological importance designated for protection under the Wildlife Act. All nature reserves are also designated as Special Areas of Conservation / proposed Natural Heritage Areas. All woodland nature reserves are on State land.

Non-vascular plant A plant without a vascular system. Non-vascular plants include mosses, liverworts and lichens.

Old growth stand A stand that has attained a great age with minimal human disturbance and consequently, exhibits unique ecological features and high biodiversity.

OLD WOODLAND See LONG-ESTABLISHED WOODLAND.

OPPORTUNISTS See RUDERALS.

PEOPLE'S MILLENNIUM FORESTS PROJECT A project undertaken to restore 16 native woodlands throughout Ireland, to mark the new Millennium. As part of the restoration process, a tree was planted for every household in the country. The project, which also included various promotional and educational measures, was sponsored by the AIB Bank and the Forest Service, and managed by Coillte in partnership with Woodlands of Ireland. See www.millenniumforests.com for details.

PIONEERS Tree species that are the first to naturally colonise open sites. Examples in Ireland include birch and common alder.

PLANT HEALTH DIRECTIVE EU Council Directive 2000/29/EC on protective measures against the introduction into the EU of organisms harmful to plants or plant products and against their spread within the EU. A new Plant Health Regulation (Regulation (EU) 2016/2031 of the European Parliament of the Council) was introduced in 2016, repealing and replacing Council Directive 2000/29/EC. This new Regulation will apply from the end of 2019.

POLE STAGE A tree between the size of a sapling and a mature tree. A forest in the early stages of thinning.

POLLARDING The practice of cutting a tree to leave a permanent trunk typically 2-4 metres in height and supporting a mass of branches above the reach of browsing animals.

PRIORITY HABITATS A subset of those habitats listed in Annex I of the Habitats Directive. Priority habitats are habitats that are in danger of disappearance and whose natural range falls mainly within the territory of the European Union. These habitats are of the highest conservation status and require measures to ensure that their favourable conservation status is maintained. Priority habitats in relation to native woodland in Ireland include bog woodland, residual alluvial forests, yew woods and limestone pavement, which can include scrubby facies comprising (*inter alia*) hazel and ash.

PROTECTED AREA A collective term applied to any area of land and / or water legally designated in order to protect and maintain biological diversity and associated natural and cultural resources. Examples include Natura 2000 sites (Special Areas of Conservation and Special Protection Areas), Natural Heritage Areas, Nature Reserves and National Parks.

PROTECTED HABITATS OR SPECIES A collective term applied to specific habitats and species of flora and fauna protected by the EU Birds and Habitats Directives, and by relevant national legislation, e.g. Wildlife Acts, Flora Protection Orders.

PROVENANCE The location from which seeds or cuttings are collected. The designation of Regions of Provenance under the Forest Reproductive Material Directive is used to help nurseries and growers select suitable material. The term is sometimes confused with 'origin', which is the original natural genetic source.

REFORESTATION Defined under the Forestry Act 2014 as the restocking by planting,

natural regeneration or coppicing of an area from which trees have been felled or otherwise removed.

Refuge area See Minimal intervention area**.**

Replacement The abrupt conversion of a non-native forest to native woodland, through clearfell and subsequent reforestation (*via* replanting and / or natural regeneration) with appropriate native species.

Replant To deliberately restock with trees an area from which trees have been felled, removed or otherwise destroyed, or to restock such other land as may be agreed with the Minister of Agriculture, Food & the Marine, but does not include restocking by means of natural regeneration (Forestry Act, 2014).

Restoration The process of assisting the recovery of an ecosystem that has been degraded.

Restoring Priority Woodland Habitats in Ireland LIFE Project A 4-year project targeting the restoration of 550 ha of priority woodland types (as per Annex I of the Habitats Directive), which have been impacted in various ways by human activities in the past. The project involved nine sites throughout Ireland, all owned and managed by Coillte. The project was jointly funded by Coillte and the EU LIFE-Nature programme (as LIFE05 NAT/IRL/000182). See www.woodlandrestoration.ie for details.

Rideline A permanent, unsurfaced strip through a woodland, maintained as open space to facilitate access and management (including deer control). Ridelines also represent important biodiversity features, and this value can be enhanced further through careful positioning, design and management (e.g. the staggered cutting of vegetation within the open habitat).

Ring-barking A silvicultural treatment involving the removal of the bark and vascular tissue (typically using a small axe) from around the entire circumference of a standing tree, for the purpose of killing it *in situ*. Applications within the native woodland context include the elimination of individual or small groups of non-native trees, and the creation of standing deadwood.

Riparian area Land directly adjacent to the edge of streams, rivers and lakes, representing the intermediate zone between the aquatic and terrestrial environments, and having its own distinctive hydrological characteristics and habitats (e.g. gallery woodland). Riparian areas are generally regarded as the land between the water's edge and the upper level of normal flooding.

Ripping A form of cultivation used to prepare certain sites for afforestation, to break up hardened soil layers for the purpose of improving soil drainage for establishing trees.

Ruderals Species of plants that colonise disturbed ground. They occur locally within woodlands where the soil has been disturbed, such as along freshly-tracked ridelines, on recently felled areas, and around animal excavations. Also referred to as 'opportunists'.

Saproxylic organisms Organisms that depend on dead and decaying wood at some point in their life cycle.

Scarification A type of forestry operation associated with efforts to encourage natural regeneration within a woodland or on a recent clearfell site. It involves lightly breaking through the ground vegetation to expose the soil to the germinating seed of trees and shrubs.

Scrape mounding A form of cultivation used to prepare a site for afforestation, whereby a small mound of topsoil is piled up, into which the tree is then planted. This creates an adjacent pit, the function of which is to aid drainage. Scrape mounding involves minimal site disturbance and creates a vegetation-free planting position, thereby reducing competition during the first growing season. However, the pit can collect standing water and can make access dangerous and difficult. This form of cultivation should be avoided on peaty soil and if used, the pit should be as shallow as possible.

Selection A CCF silvicultural system in which felling and regeneration are distributed over the whole stand and over time, with individual large trees or small groups of trees selected for felling in any single intervention. Its application results in a continuous series of age classes and diameters.

Semi-natural woodland Woodland that resembles natural woodland cover, dominated by native trees and shrubs but considerably altered by human activity. Stands originating from previous planting and / or coppice may be termed 'semi-natural' if they are now regenerating naturally.

Shade tolerant species Species of trees and other plants that are able to survive at low light levels beneath a woodland canopy.

Shaping A silvicultural treatment involving the early pruning of strong side branches and forked leaders, to promote strong leader development in a young broadleaf tree. Typically undertaken to promote stem quality for future wood production. Also referred to as 'formative pruning'**.**

Shelterwood A CCF silvicultural system that aims to secure natural regeneration under the shelter of older trees, which are then removed by successive cuttings to allow the young trees to grow on to maturity.

Silviculture The science of establishing and / or managing a woodland or forest to achieve a certain objective or range of objectives. It is based on a detailed knowledge of the current characteristics of the tree population within the woodland, and how these will react over time to various influences, both natural and artificial (e.g. thinning).

Special Area of Conservation (SAC) A prime wildlife conservation area considered to be important at a European as well as an Irish level, designated under the Habitats Directive. Also referred to as a 'Natura 2000 site'.

Special Protection Area (SPA) An area of significance for the conservation of habitats which are important for birds and have been designated under the EU Council Directive 79/409/EEC on the conservation of wild birds (or 'Birds Directive'). Also referred to as a 'Natura 2000 site'.

Spiral guard A device fitted around the base of a newly planted tree, to prevent stem damage from rabbits and hares.

Stand A discrete unit of woodland, as distinguished by a common characteristic or range of characteristics such as age or species. Woodlands are commonly divided into

stands, for management purposes.

Stem injection A method of applying herbicide to control unwanted woody species (e.g. invasives such as rhododendron and cherry laurel), involving the direct injection of the compound into the stem(s) of individual plants. Typically only suitable if treating older growth with larger diameter stems.

Stump application A method of applying herbicide to control unwanted woody species (e.g. invasives such as rhododendron and cherry laurel), involving the direct application of the compound to the freshly-cut stump of individual plants.

Sustainable Forest Management (SFM) *"The stewardship and use of forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems."* (From the Ministerial Conference on the Protection of Forests in Europe, Helsinki, 1993.)

Thicket A close, visually impenetrable stand of young trees and / or shrubs.

Thicket stage Within a silvicultural context, the stage in the emergence of a new woodland canopy at which the side branches of adjoining trees meet and individual canopies merge.

Thinning Defined under the Forestry Act 2014 as the removal from a forest in accordance with good forest practice of excess or diseased trees, or trees of poor quality in order to improve the growth, health and value of the remaining trees. Thinning can also be undertaken to achieve other objectives, such as the promotion of the ground layer or the understorey, to enhance biodiversity.

Timber A piece of wood, typically a plank or beam, prepared for use in building, carpentry, etc. Defined under the Forestry Act 2014 as the wood produced by a tree, whether or not the tree is standing.

Topsoil The uppermost layer of the soil, in which most of the nutrient cycling and biological activity takes place.

Transformation The process of changing from an even-aged stand structure to a multi-aged stand structure, using continuous cover forestry. Within the native woodland context, transformation can be described as the gradual conversion (over a number of years or decades) of a non-native and predominantly even-aged forest to an uneven-aged native woodland, through the use of CCF.

Transplant A tree seedling or cutting that has been transplanted at least once in the nursery.

Tree A woody plant, with a single or multiple stems (trunks), that lives for many years and is typically capable of growing to over 5 metres in height (or 4 metres on waterlogged soil). Defined under the Forestry Act 2014 as a free standing woody perennial plant whose species has the potential to have a more or less definite crown and be capable of reaching a minimum height of 5 metres at maturity and includes a sapling and the species of birch and hazel.

Tree guard See Tree shelter.

Tree shelter A tube placed over individual trees immediately after planting, and

secured to a stake. Its purpose is to create a favourable micro-climate to promote establishment and early growth, and / or to protect against grazing (often referred to as a 'tree guard' in this context). Within native woodland management, tree shelters are often used when restocking an existing native woodland or to protect against deer.

UNDERSTOREY The layer of vegetation, usually comprising shrubs and / or regenerating trees, growing beneath the canopy of a woodland or forest, but above the field layer. Within a silvicultural context, the term also applies to trees within the lower canopy level.

UNDERSTOREY PLANTING The planting of individual or small groups of trees of shade tolerant species beneath small gaps within an existing woodland canopy, for the purpose of rejuvenating the woodland and / or altering its species composition.

UNITED NATIONS CONVENTION ON BIOLOGICAL DIVERSITY International convention (1992) on the protection of global biodiversity. Its implementation in Ireland is set out in the National Biodiversity Plan, developed by the Department of Arts, Heritage, Regional, Rural & Gaeltacht Affairs, with cross-sector input.

VASCULAR PLANT A plant having a vascular system of conducting tissues, e.g. ferns, conifers and flowering plants.

VEGETATION MANAGEMENT The control of competing grasses and herbaceous plants around the base of a young tree, to suppress competition for water, nutrients and light, and to aid establishment.

VERMICOMPOST A substance made from organic matter (such as farmyard manure or vegetable waste) that has been broken down by earthworms. When applied at planting, it can promote the uptake by young tree roots of existing nutrients in the soil, through fungal associations, thereby representing a possible alternative to fertiliser inputs on sensitive sites.

VETERAN TREE A tree of exceptional age and / or a tree surviving past full maturity, typically exhibiting crown retrenchment. Such trees – whether native or otherwise – are important for forest biodiversity, as they provide a range of habitats for invertebrates, birds and other animals (e.g. deep fissured bark, broken snags, cavities, dead branches). Also, veteran trees are often of cultural and / or landscape value. Also referred to as 'ancient tree'.

WATER FRAMEWORK DIRECTIVE (2000/60/EC) An EU Directive requiring all Member States to protect and improve water quality in all waters so as to achieve 'Good' status. It was given legal effect in Ireland by the European Communities (Water Policy) Regulations 2003 (S.I.722 of 2003). The Directive applies to rivers, lakes, groundwater and transitional coastal waters. It requires the preparation of management plans on a river basin basis and specifies a structured method for developing these plans. The Water Framework Directive is linked to a number of other EU directives, including those relating to the protection of biodiversity, primarily the Birds and Habitats Directives. See www.catchments.ie for details.

WATER SETBACK See AQUATIC BUFFER ZONE.

Wildlife Acts The Wildlife Act 1976 and the Wildlife (Amendment) Act 2000, together with the European Communities (Birds & Natural Habitats) Regulations 2011 (S.I.477 of 2011), form the most important legislation underpinning biodiversity and nature conservation in Ireland. Provisions include (*inter alia*): the control of certain activities that may adversely affect wildlife; a mechanism to give statutory protection to Natural Heritage Areas; and measures to enhance the conservation of wildlife species and their habitats. See www.npws.ie/legislation/irish-law for details.

Windblow See Windthrow.

Windrowing A forestry operation whereby tree tops and branches left behind after clearfell (typically) and extraction are gathered by machine into rows or piles onsite, to facilitate access for reforestation.

Windthrow A natural process whereby trees are uprooted and blown over by wind. The risk of windthrow can be exacerbated by various factors, e.g. the inappropriate thinning of a mature even-aged crop of Sitka spruce on an exposed peat site. (Related processes include wind rocking and wind snap.) Also referred to as 'windblow'.

Wood The collective term for the hard woody parts of a tree that can be recovered and used for a range or products, including building material and fuel.

Woodland dynamics The processes in which woodlands and forests develop and expand (or contract) over time, as constituent trees and tree species are influenced by each other, by the physical and climatic factors of the site, and by human intervention.

Woodland generalists Species of plants and animals characteristic of woodland habitats but which may also occur outside woodlands.

Woodland specialists Species of plants and animals that are adapted to living in, and requiring the characteristic habitats of, woodland. Some of these species may be unable to live outside woodlands, and others may be confined to ancient woodland.

Woodlands of Ireland A not-for-profit company with charitable status, established in 1998 to promote the conservation, expansion and sustainable development of native woodlands. Funded and supported by the Forest Service, National Parks & Wildlife Service and the Heritage Council. See www.woodlandsofireland.com for further information.

Yield Class An index used to describe the potential productivity of an even-aged stand of trees. It is based on the maximum mean annual increment of cumulative timber volume achieved by a given species growing on a given site and managed according to a standard management prescription. It is measured in units of cubic metres per hectare per year.

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